Proceedings of the

1st Symposium on Laptop Ensembles & Orchestras

Louisiana State University

Baton Rouge, Louisiana

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PREFACE

The idea for this symposium was born out of discussions between myself, Rebecca Fiebrink, Jesse Allison and Nathan Wolek about the state of research in performance ensembles that use laptops and mobile devices as their primary technology. The success of groups such as the Princeton and Stanford Laptop Orchestras (PLOrk & SLOrk, respectively), the Linux Laptop Orchestra (L2Ork), the Mobile Performance Group, and our own Laptop Orchestra of Louisiana (the LOLs), along with the rapid growth of official (and unofficial) ensembles at universities across the globe, has demonstrated that there is a new and important culture within the world of electronic and computer music.

Our initial discussions revolved around the notion that despite all of this activity, there was little coordination or organization between ensembles, no consensus or discussion of what were best practices, and no opportunity to teach composers and performers who want to start their own laptop ensemble the how-to's (and how-not-to's) of this unique musical environment. Hence was born SLEO, the Symposium on Laptop Ensembles & Orchestras.

These proceedings are a documentation of the papers and posters that have been presented at the symposium, and are meant to be a starting point for anyone interested in developing their own ensemble, as well as a snapshot of the current state-of-the-art. While we do not know whether there will be more SLEOs in the future, I am confident that the knowledge we have brought together here will be of long lasting importance to our field, and to the history of contemporary music.

My sincerest thanks to the SLEO Program Committee who reviewed all of the submissions, to Jesse, Rebecca and Nathan who have invested their energies into organizing the meeting, to the staff of the LSU Center for Computation & Technology for their help in putting on the conference, to our academic and corporate sponsors who have underwritten this event, and to all of the ensembles who have agreed to participate. Most importantly, my thanks to everyone who submitted their research and creativity to SLEO 2012. Without your contributions, there would be no event.

Stephen David Beck
Chair, SLEO 2012

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Table of Contents

WIND FARM, A COMPOSITION FOR LAPTOP ENSEMBLE

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ABSTRACT

The author discusses *Wind Farm*, his composition for a laptop ensemble of at least seven players. The piece features two sound-creation interfaces, implemented in MaxMSP, and conductor software that determines some aspects of the sound made by individual players. The conductor and players communicate over a wireless network. The gestural control interface is simple, requiring only the built-in trackpad, with an inertial scrolling algorithm, and computer keyboard. A Jitter patch provides optional video accompaniment.

1. INTRODUCTION

Wind Farm, a composition for laptop ensemble, was written at the request of the Electric Monster Laptop Ensemble at Montana State University, under the direction of Hsiao-Lan Wang, and has been performed by them, as well as by the CEnsR Ensemble and the Arazzi Laptop Ensemble. The piece touches metaphorically on the promise and problems of wind energy. Wind turbines are an important source of renewable energy, but the turbines kill birds, disrupt habitats, confuse airplane and weather radar, and spoil natural views. The members of the ensemble are drawn together in a common musical effort that represents the hope that at least some of these problems will be solved.

The *Wind Farm* software comprises three performance interfaces, implemented in MaxMSP: a filtered noise instrument (*blow*), suggestive of the wind; a resonant click instrument (*spin*), reminiscent of the sound of pinwheels or spinning wheels; and a conductor patch, which plays a drone during the run-up to the high point of the piece, but otherwise sends messages to the other players over a wireless network.

The music is a structured improvisation. The conductor navigates a set of textural cues and pitch collections to guide the players, who focus on gestures and timbral shaping. In limiting the aspects of sound that players can change, the aim is to find a fruitful balance between the creative contributions of the individual players and the establishment of a clear overall shape and purposeful harmonic progression.

2. IMPLEMENTATION

2.1. Low-key Conducting

Many laptop ensembles, such as the pioneering Princeton Laptop Orchestra (PLOrk), sometimes employ a human conductor to lead the ensemble [1]. Although these conductors have developed new ways of communicating with players (for example, via hand signals), they can retain the sense of hierarchical organization familiar from traditional Western orchestral practice, which was not considered desirable for this particular piece.

The conductor of *Wind Farm* maintains a lower profile. The conductor establishes a TCP/IP network connection with each of the players in the ensemble. Then she walks through a cue list. A *cue* here serves two functions: it displays a message for the player that briefly describes the texture and density to achieve, and it triggers instantaneous and gradual parameter changes. The conductor also moves through a set of pitch collections—one for each group of players, *blow* and *spin*. The pitches are distributed to the players in a way that scales transparently to the number of available musicians. The timing of cue and pitch changes is completely under the control of the person conducting, and so her job is to listen carefully to the players' improvised gestures and determine the best times to request changes. All of this guidance happens in a visually inconspicuous manner.

2.2. Spinning

The two sound-producing patches, *spin* and *blow*, let the players control their sound within the pitch and parameter constraints provided by the conductor. In either case, the musician uses the built-in trackpad and keyboard of the laptop to shape the sound.

The *spin* patch implements *inertial scrolling*, familiar from the iPhone and similar devices, to allow the musician to generate a decelerating series of clicks. While your finger is on the trackpad, you can create individual clicks and short, fast streams of clicks. If your finger leaves the trackpad with enough momentum, the clicks continue a while before slowing to a stop. The inertial scrolling is implemented by feeding cursor position deltas from the Max *hi* (human interface device) object to a Javascript port of the FlickDynamics Objective C code, graciously offered

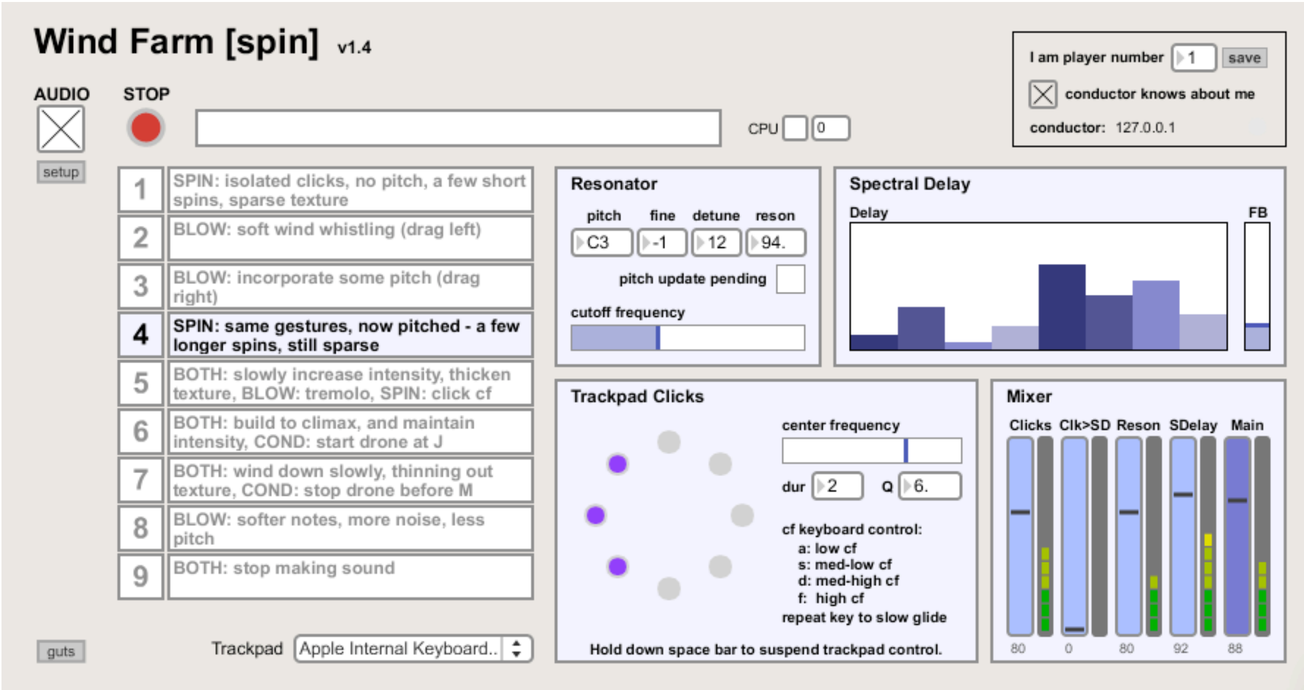

Figure 1. The *spin* patch from *Wind Farm*.

under the BSD license by Dave Peck [2]. (This seems to work only on Mac OS X; the built-in trackpads on Windows laptops this author has tried are not visible to the *hi* object. Unfortunately, the *hi* object is the only way to receive position deltas even while the cursor is pinned to an edge of the screen, a common occurrence when using the trackpad for inertial scrolling.)

The clicks so generated run through several processing modules before leaving the patch: a delay-based resonator, a resonant low-pass filter, and a recirculating spectral delay (see Figure 1). The spectral delay relies on the author's *jg.spectdelay~* external object, with source code available under the General Public License (GPL) [3].

The beginning and ending of the piece present a monochromatic sound world, with only a weak sense of pitch, in contrast to the more colourful, strongly pitched sense of the rest of the music. The pitches are imposed by the resonator, while filter sweeps, controlled by a simple computer keyboard scheme, impart dramatic timbral contrasts between the sounds of the individual *spin* players.

2.3. Blowing

The *blow* patch lets the musician create a variety of filtered noise and other sounds by dragging a finger across the built-in trackpad, but without the inertial scrolling implemented in the *spin* patch. Although the trackpad is only a two-dimensional device (assuming no multi-touch capabilities), the *blow* patch divides an on-screen target rectangle into several regions that enable multi-dimensional control (see Figure 2). For example, dragging to the left of center produces filtered noise with a relatively narrow bandwidth, while dragging to the right triggers a sustained, clear pitch, generated by the author's port of the BlowBottle physical modelling instrument from the Synthesis Toolkit (STK), by Perry Cook and Gary Scavone [4]. Near the climactic part of the piece, a sparse granular synthesis texture joins these other sounds, controlled by passing your finger through other regions of the target rectangle.

The player also operates a simple tremolo processor using the computer keyboard, while she controls overall volume with the Y axis of the trackpad.

3. PERFORMANCE CONSIDERATIONS

3.1. Spatialization

The *blow* and *spin* patches generate monophonic audio output, intended for reproduction by hemispherical loudspeakers. This type of loudspeaker is well suited to laptop ensemble performance, because it disperses sound in a much wider pattern than does a conventional loudspeaker, leading to a more natural, less focused sound, and making it easier for ensemble members to hear each other without using separate monitor speakers [5]. Placing the hemisphere as close as possible to the performer makes it more clear to the audience who is producing what sound, a consideration especially important for a medium in which there can be no fixed expectation of the kind of

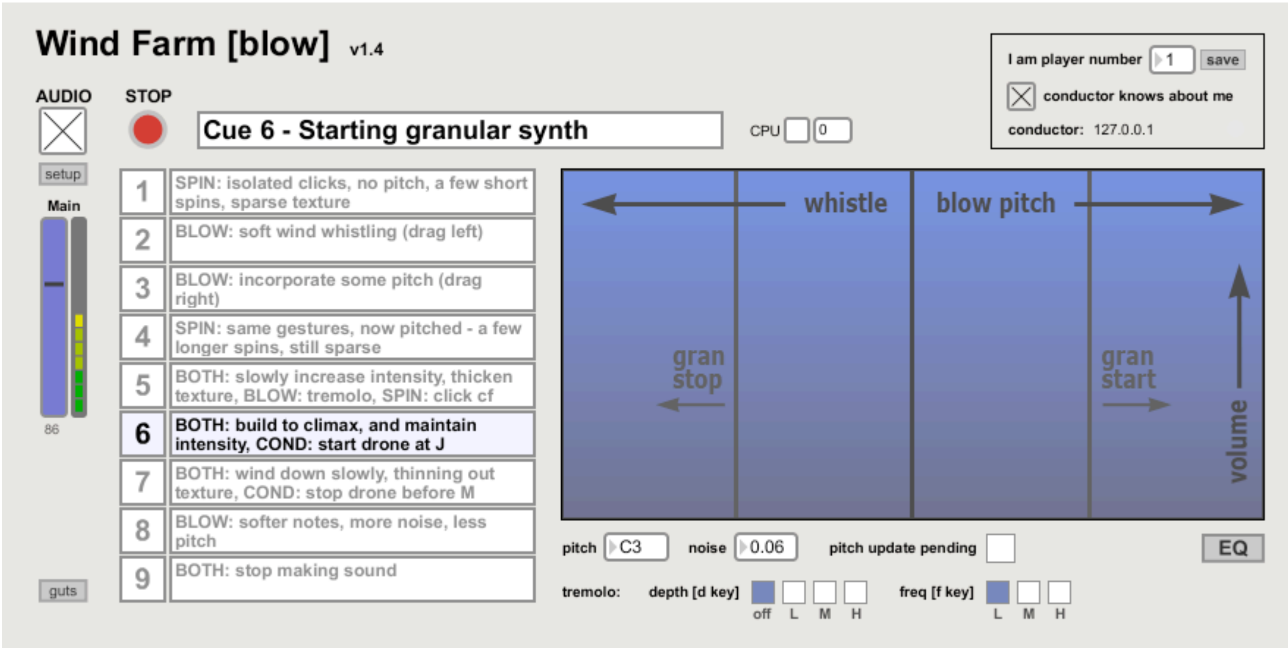

Figure 2. The *blow* patch from *Wind Farm*.

sound produced by a given musician. Placing players and speakers around the stage area with a reasonable amount of separation yields a vibrant, open sound with a great deal of spatial interest.

One drawback of the typical hemispherical loudspeaker is its lack of bass response. The *blow* and *spin* patches were designed to produce sound well above 100 Hz. Although the conductor plays only a single drone sound during one part of the piece, she has the distinction of generating both full-range audio, including a very deep bass that the other musicians cannot produce, and stereo sound. For this reason, the conductor requires a full-range stereo sound system, preferably equipped with a subwoofer.

3.2. What to Watch

For anyone witnessing a laptop performance, it can be hard to dismiss the nagging thought that the performers are merely checking their email. They sit motionless and stare at screens, oddly detached from the lively sounds they produce. This can be alienating for the audience, because we are so used to thinking that people are shutting us out if they are engrossed in their computer. In *Wind Farm*, a *spin* performer can alleviate this feeling somewhat by exaggerating the physical production of his inertial scrolling trackpad gestures, by moving his arm more than is really necessary. If he sits with the laptop tilted so that the audience can see the trackpad, it makes it easier for an audience member to understand what is happening. But there is probably no effective way for the *blow* player to communicate his actions to the audience, so small and precise are the finger movements required.

Partly for this reason, *Wind Farm* includes a Jitter patch that allows for live processing and compositing of wind turbine video loops during the performance. Interestingly, the Arazzi Laptop Ensemble, who performed *Wind Farm*, did not want to use the video, because they believed that an audience is less able to listen intently if distracted by an active visual element.

3.3. Listening

The musical structure of *Wind Farm* encourages the players to listen to each other. In the quieter moments of the piece, when one person spins, the others should leave enough room for the gesture to speak. When a *blow* player sweeps the filter in a particular way, the others can complement this move. Because a player is not in control of her pitches, at any time she might receive notification that a new pitch has arrived from the conductor. Then she should complete her current gesture before starting another with the new pitch, all the while listening for the right moment to make the change.

It is satisfying that basic musical instincts and values can find expression in a performance context as technologically mediated as the laptop ensemble.

3.4. Performance Materials

Patches and performance information for *Wind Farm* are available at http://john-gibson.com/pieces/windfarm.htm.

4. REFERENCES

[1] http://plork.cs.princeton.edu (accessed March 14, 2012).

[2] http://gist.github.com/100855 (accessed March 14, 2012).

[3] Gibson, J. "Spectral Delay as a Compositional Resource," in *eContact!* vol. 11.4, *Toronto Electroacoustic Symposium 2009*, Canadian Electroacoustic Community, October 2009. Available online at http://cec.sonus.ca/econtact/11_4/gibson_spectraldelay.html (accessed March 14, 2012).

[4] http://ccrma.stanford.edu/software/stk (accessed March 14, 2012).

[5] Trueman, D., Bahn, C., Cook, P. "Alternative Voices for Electronic Sound," in *Proceedings of the International Computer Music Conference*, Berlin, Germany, 2000.

'GAME THEORY': A COMPOSER'S PERSPECTIVE ON PLAY, DANGER & INTERACTION IN COMPOSING FOR LAPTOPS

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ABSTRACT

The essay reflects on a composer's personal experiences in composing for laptop ensemble with the undergraduates of the Princeton Laptop Orchestra (PLOrk). Using the author's recent piece *Slip* (2011) for six laptops with joystick controllers as a point of reference, the essay considers three elements that have been important for the author's creative process in working with laptops: *play*, a tactile pleasure in the process of music making; *danger*, elements of uncertainty in the outcome of a performance; and *interaction*, the interdependence between the laptop collaborators. These elements are examined in the context of a game-like attitude toward music-making, from the perspective of a 'traditionally' Western-trained composer fascinated by the new possibilities of a laptop ensemble.

1. INTRODUCTION

Laptop ensembles are an exciting place to spend some quality time; while there, I feel like I'm in the laboratory of a collective of mad scientists with a funky sense of humor. As a composer with a strong background in 'traditional' performance and notes-on-paper composing, working with laptops has been a liberating experience. Rather than using my musical skills in well-worn settings that I have developed over years of musical training, I feel free in this musical medium to re-imagine those skills. The newness of the situation gives me the chance to try things out that would seem crazy, or simply be impossible, in another context. [4,7] Although I've been involved in making music with groups of laptops for over six years now, it still seems like a totally new game to me.

Game is in fact a good word here. For me, the most interesting music for groups of laptops – as opposed to a solo performer or a tape piece – finds a way to construct a sense of three 'game-like' things: play, danger, and player interaction. By *play*, I mean a tactile pleasure in the process of making music; by *danger*, a degree of uncertainty in the outcome; and by *interaction*, an interdependence of each laptop performer with the others. These three features have certainly played an important role for me in working with groups of laptops, both as an end goal for the piece and during the stages of creation.

I began thinking about play, danger and interaction while working on a recent piece, *Slip* (2011). *Slip* was created for six laptop performers with joysticks, and one 'conductor' laptop. The conductor laptop sends a series of instructions to the performers over the local network to which all of the laptops are connected. These can either be the automated commands that I have created to give an overall shape to the piece; or, they could be invented by another human conductor and sent manually over the network. *Slip* was created for a concert with the Princeton Laptop Orchestra (PLOrk) while I was a teaching assistant for the yearly spring undergraduate PLOrk seminar at Princeton. The seminar prepares the students, as performers in the laptop orchestra, for a culminating concert, introducing elements of electronic music and programming along the way. [8] In this essay, I would like to consider the three features I have identified – play, danger, and interaction – in detail, in the context of the development and first performance of *Slip*.

2. PLAY

By *play* I mean the pleasure or flow we experience in an exploratory process of music making. [5][1] Play was not only an end goal that I kept in mind for the performers of *Slip*, but also an important part of the process of creation. In the latter context, it is a term that gets regularly used informally among fellow composer-programmers. [1]

2.1. Performers at Play

One of my initial goals for *Slip* was to try and get players physically engaged with their computers as music-making tools. To this end, I used a tried-and-true video game interface – the joystick. In each of the two instrument modes used in the piece – 'percussion' and 'arpeggiator' – I mapped musical parameters in a relatively 'straightforward' linear way.

In 'percussion' mode, the overall volume increases as the stick is moved away from the entirely silent center

[1] Stratton-Smith (2001) discusses play in its many forms at length. In the opening of his book he writes (playfully?): "We all play occasionally and we all know what playing feels like. But when it comes to making theoretical statements about what play is, we fall into silliness." (p. 1)

position. The mix of the various percussion sounds varies depending on the joystick placement along each axis. One or more sounds are loudest in each of the four corners – i.e., both X- and Y-axes at their extremes (see Figure 1).

Snare ↖ ↗ *Hi-Hat & Snare*

silence

Scratch ↙ ↘ *Kick Drum*

Figure 1. Joystick controls for 'percussion' mode.

In *Slip*'s 'arpeggiator' mode, the left-right X-axis controls the timbre of the repeated note cycles. The Y-axis controls the number of subdivisions (from two to sixteen) in each slow, networked pulse. Twisting the joystick (its 'Z-axis') changes the register of some of the notes randomly, either higher – when rotated to the right – or lower – when rotated to the left (see Figure 2). Although the mappings are straightforward, I spent a great deal of time crafting the resulting sounds (by adjusting ranges, values, etc.) in order to create a satisfying experience of play.

Speed

\+

↑

\- ← ↺ → + *Tone*

↓

\-

Figure 2. Joystick controls for 'arpeggiator' mode.

2.2. Composer at Play

Finding the exact values for the mapping involved many hours of trial and error – essentially a process of play in itself. [1] In some ways this isn't so different from my process in writing a piece of acoustic concert music, when I write a piece at a more traditional instrument, figuring out the gestures and pitches and rhythms as I go, and translating between the head, the body, and the written page. [3] With the laptop orchestra, I am being inspired by a different set of limitations, slipping outside of my comfort zone and trying to program a simple musical instrument at the computer.

The final result of this process – a linearly 'logical' mapping with intuitively determined values – proved to be simple but fun for me and for the players. It left them free to focus on play during performance in relation to the other two features, danger and interaction.

3. DANGER

In spite of the simple linear mapping used, my intuitive approach to assigning parameters and values to this mapping resulted in some unexpected consequences – *danger*, in a positive sense. Danger is the unexpected, the possibility that a performance could blow up at any moment, or take a new, unexpected turn. It's part of what makes a live concert more exciting than a recording. [2] It's part of what makes a group of live laptop performers different than the playback of a tape piece.

Danger arose during my creative process as I hacked code up to and above my limited composer-ability level. Sometimes, for example, the FM synthesis I had patched together created unusual glitches and bleeps. I smoothed some of these out; others I played up, because I liked the unpredictable element they introduced when playing. Another bug in my code controlling a synth envelope created beautifully unexpected sustained tones, which later became a new section of the piece.

Danger was also something I consciously built into *Slip*. For example, the rhythmic patterns played by each laptop in the percussion mode are not synced automatically; instead, the players have to manually sync to each other by clicking the trigger button on the joystick in unison. This never works 100% perfectly, and for me that's the beauty of it. The sonic implications of this imprecision are a wonderfully smeared sequence of events that almost line up, but not quite.

4. INTERACTION

The element of danger created by manually syncing the percussion patterns is also a function of *interaction*. The co-ordination of these patterns required simultaneous visual interaction and physical movement by all six performers. Interaction happens in most musical performances (hopefully), simply through the act of listening. I would like to focus, though, on other possibly more unique interactions within the laptop orchestra.

4.1. Interaction During the Creative Process

During the creative process, unique interactions arose from both (1) the weekly, interactive rehearsal-seminar structure of PLOrk [8] and (2) the informal and collaborative nature of the laptop composer-performer community. I had more rehearsals for this piece than I have *ever* had for an acoustic music composition for the concert hall, and the newness and structural fluidity of the laptop ensemble makes it very forgiving of bringing in new ideas that are still under development for workshopping with, and critique by, other performers and composers. Two fellow laptop composers who were also writing pieces for the group – Jeff Snyder and Jascha Narveson – were invaluable in developing this piece. The three of us spent a

number of hours together during and after rehearsals, both working through bugs in the code and tweaking the concept and content of our pieces.

4.2. Interaction In Performance

4.2.1. The role of the conductor

The network is one of the more unique interactive features of the laptop orchestra that I mentioned briefly in the introduction. In addition to sending instructions, the conductor also sends a coordinated pulse to all of the laptops while they are in 'arpeggiator' mode. As I mentioned in Section 3 above, I consciously avoided the use of a network for the 'percussion' mode for specific creative reasons. In the 'arpeggiator' mode, having the networked pulse frees up the performers to focus on timbre and density of sound rather than rhythmic coordination.

A. *1-6: Percussion – Start on cue from player 1*
B. *1-2: To Arpeggiator – Press & hold trigger, move joystick freely*
C. *3-4: To Arpeggiator – Press & hold trigger, move joystick freely*
D. *1-3: On Laptop – Gradually add C's (any octave)*
E. *5-6: To Arpeggiator –Press & hold trigger, move joystick freely*
F. *1-3: Add Other Notes – C, C#, E, F#, G, A, A#*
G. *4-6: On Laptop – Gradually add C's (any octave)*
H. *4-6: Add Other Notes – C, C#, E, F#, G, A, A#*
I. *1-6: On Cue From Player 1 – Set to preset 3, adjust cycle lengths (on laptop)*
J. *1-6: To Joystick – Flock to Red*
K. *1-6: Flock to Purple*
L. *1-6: Set to Preset 4 on Laptop – Return to joystick*
M. *1-3: Flock to Green @ SP9* *4-6: Flock to Blue @ SP6*
N. *1-3: Flock to Aqua @ SP6 then SP5* *4-6: Flock to Yellow @ SP9 then SP10*
O. *1-6: Loner*
P. *1-3: Flock to Green @ SP10 to SP12 to SP15* *4-6: Flock to Yellow @ SP6 to SP5 to SP4 to SP3*
Q. *1-3: Flock to Aqua @ SP16* *4-6: Flock to Yellow @ SP16*
R. *1-6: Press and Hold Trigger – set to Preset 1 – move joystick freely*
S. *4-6: Percussion – Start on cue from player 6*
T. *1-3: Percussion– Start when you are ready*
U. *1-6: Stop on cue from player 1*

Table 1. Automated instructions sent by the conductor over the 7-½ minutes of the piece. Numbers at the beginning of each direction indicate which players should follow it. 'SP' followed by a number indicates a specific speed or density of rhythmic activity, as set by the Y-axis of the joystick in Arpeggiator mode.

4.2.2. The role of the other performers

The large-scale form for *Slip* was organized by directions from a conductor, but it is the performers that interpret these commands from moment-to-moment. The performers make choices in different ways over the course of the piece, from which octave to put a pitch in to what sequence of pitches to use, from the quality of timbre to the density of rhythmic subdivisions. Players were, I hope, actively engaged in this by listening to the results of their actions at the laptop and the joystick. There were also, however, other means of communication by which players interacted with the piece, and one of these in particular best illustrate how play, danger, and interaction can work together to create musical performance.

5. PLAY, DANGER AND INTERACTION IN CONCERT: THE DEVELOPMENT OF A NEW INTERACTIVE INTERFACE

The interactions made possible during the relatively egalitarian rehearsals allowed for many additional refinements to *Slip*, as I solicited feedback from the performers and observed the engagement of play, danger, and interaction in the rehearsal process. One of the most significant examples of this was in the development of the performers' graphic user interface. I created an initial visual interface allowing the players to see the X-Y position of their joystick as a sphere in a rectangular box. This was initially imagined simply as a way to help the performer more precisely keep track of where along each axis (s)he was, since their physical movements from one extreme of the joystick to the other are relatively subtle. During rehearsal, however, a desire was voiced by some of the performers to be able to see and identify each and every other performer's movements.

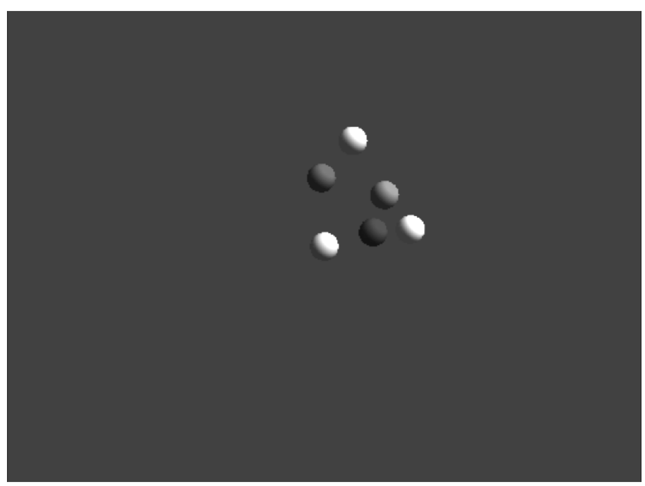

Figure 3. A partial screenshot of one of the players, showing the locations of each of the six players in X-Y joystick space, as a uniquely colored sphere.

This gave me new ideas in developing *Slip*, and the visual interface became a critical element for interactive play between performers over the course of the piece (see Figure 3). Having each performer on every screen as a uniquely colored sphere allowed moments of more literal game-playing, which also generated new sonic gestures that I would not have created otherwise. While using the 'arpeggiator' mode during an extended section of *Slip*, players are sent instructions to either 'flock' to one of the players (identified by color) or to be a 'loner'. As a flock, the leader is free to move around the X-Y space however (s)he desires, or within certain limits set by the conductor, while the other players follow her/him as closely as possible around the screen As loners, the players avoid all contact with the other players on the screen, moving freely or staying still. The resulting changes in timbre and rhythmic activity were complex and unpredictable, while still following certain large-scale outlines from performance to performance: maintaining an element of danger, while keeping it confined within a loose compositional structure. This strikes me as very similar to the way in which video game players make choices within the programmed structures of a game.

The game-like interactions happening between players on the visual interfaces of *Slip* may also help to replace the visual, theatrical interplay observed in more 'traditional' performance situations. It raises the possibility of whether to present this visual representation of play to the audience as part of *Slip*. [7] I haven't yet tried this, though it might well be effective and appropriate – the motions of the players turns out to be much more subtle on stage than I had at first imagined, and do not convey the playfulness of what is happening between the performers and on-screen.

6. CONCLUSION

Play, danger, and interaction relate to improvisation as much as (or even more than) composition. I am fascinated by the ways in which the laptop ensemble has helped me to re-imagine ways to give musicians degrees of freedom to interact within the self-imposed and medium-imposed constraints of compositional game-play. [6] With *Slip*, I feel that I have found new ways for me as 'composer-facilitator' to create opportunities for performers to collectively participate in the narrative-making process of a piece. Performer involvement in *Slip* is different at least in kind, if not degree, from performer involvement in my more traditionally notated concert music.

So far, for me, laptop composing has been a testing ground for new ideas; each new experience with laptops has helped me re-imagine my compositional process. I look forward to continued work in PLOrk and elsewhere to develop a 'tradition' of performance practice out of all of the exciting newness of the laptop ensemble, allowing more advanced, virtuosic, intimate music-making to happen. [7][2] As both performer and composer-facilitator, the laptop ensemble reminds me to have fun; to make mistakes; and to look, listen, and respond.

7. REFERENCES

[1] Fiebrink, R., D. Trueman, C. Britt, M. Nagai, K. Kaczmarek, M. Early, MR Daniel, A. Hege, and P. Cook. "Toward understanding human-computer interaction in composing the instrument," in *Proceedings of the International Computer Music Conference*, New York & Stony Brook, NY, USA, 2010, pp. 136-142.

[2] Lansky, P., and J. Perry "The Inner Voices of Simple Things: A Conversation with Paul Lansky," in *Perspectives of New Music* **34**(2), 1996, pp. 40-60.

[3] Mackey, S. "Music as an Action Sport," in *Current Musicology*, Columbia University, 1999, pp. 269-288.

[4] Smallwood, S., D. Trueman, P. R. Cook, and G. Wang. "Why a laptop orchestra?" in *Computer Music Journal* **32**(1), MIT, 2008, pp. 9-25.

[5] Sutton-Smith, B. *The Ambiguity of Play*. Cambridge, MA: Harvard University Press, 2001.

[6] Toop, D. "Search and Reflect: the Changing Practice of Improvisation" in *New Sound* **32**(II), Belgrade, Serbia, 2008, pp. 119-129.

[7] Trueman, D. "Why a laptop orchestra?" in *Organized Sound* **12**(2), Cambridge University Press, 2007, pp. 171-179.

[8] Wang, G., D. Trueman, Smallwood, S., and P. R. Cook. "The Laptop Orchestra as Classroom," in *Computer Music Journal* **32**(1), MIT, 2008, pp. 26-37.

[2] Trueman (2007) discusses establishing a 'performance practice involving instrument building'.

COMPOSER PERSPECTIVE ON *WHAT THE WHAT: A COLLECTION OF LAPTOP ORCHESTRA WORKS FOR WII-MOTES*

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ABSTRACT

This paper is a composer's perspective on a group of three works for laptop orchestra for Wii-motes. Each work deals with issues of Laptop Orchestra practice and performance in varying perspectives. This paper uses each piece as an example to address varying hurdles of typical laptop orchestras and the composer's solutions for each, such as the distribution of control data and performance instructions, minimizing setup time, time syncing, and hierarchical structures both in the performance and control realm.

The paper will briefly address the aesthetic and compositional goals and then will identify difficulties and solutions for each situation.

This 'composer perspective' highlights musical and technical differences in the *What the What* series, as well as note the difficulties I've encountered from design, rehearsal, and performance of each piece.

1. INTRODUCTION

What the What is a grouping of three works for laptop orchestra consisting of *What the Bells* (2010), *What the Freq* (2011), and *What the Pluck* (2012). Each work involves the use of a laptop and Wii-mote controllers as the performer's immediate control interface. MaxMSP is used for the audio synthesis and laptop synthesis. OSCulator is used to connect the Wii-mote controller data with MaxMSP through Open Sound Control.

Compositionally, each piece begins with a basic performance gesture on the Wii-mote that mimics a familiar acoustic instrument. *What the Bells* borrows the performance motion of hand bells. *What the Freq* borrowed performance motions of handballs, shaker and agogo. *What the Pluck* borrows motions from cello plucking and bowing.

A familiar gesture resulting in a familiar musical sound as a starting point, from which it may or not deviate, was one of the primary compositional concerns. The beginning of each work makes a musical connection by having the borrowed gestures possess 'emerging sounds' [2] modeled from their familiar acoustic counterparts. One commonality in the series is my personal response to the ubiquitous action-response dilemma replete in Laptop Orchestra music: the use of Wii-motes as gestural controls. The ideas of 'composing an instrument' as well as 'privileging the gesture/sound relationship'[1] [1] have been a compositional and design priority throughout the series. And while I do feel some uses of overly demonstrative gestures and visuals in some pieces, can be seen as pandering to unfamiliar audiences, the purposeful use of Wii-motes aims to build a consistent starting point for *familiarity* and *understanding*-- two things I feel that are necessary for musicians and audiences to move beyond the visually superficial question of 'what are they doing?' and become more musically engaged.

Beyond the consistency of using Wii-motes and a familiar gestural starting point, the three works vary in control and performance data distribution, sound synthesis models, musical form, inter-laptop communication, performance hierarchy, and notation.

2. WII-MOTES

2.1. Pairing

For *What the Bells,* pairing Wii-motes prior to performance presented numerous challenges. Several options on how to receive Wii-mote data were considered, such as Masayuki Akamatsu's aka.wiiremote[2] Max object, Darwiimote, and Camille Troillard's OSCulator[3]. OSCulator appeared to be the most stable and was able to handle several Wii-motes at one time.

Difficulty came when pairing specific Wii-motes with specific laptops. Often times, the OSCulator application from another laptop would pair with a different set of Wii-

[1] Fiebrink, R., Trueman, D., Britt, C., Nagai, M., Kaczmarek, K., Early, M., Hege, A., et al. (2010). TOWARD UNDERSTANDING HUMAN-COMPUTER INTERACTION IN. *Organised Sound*. Retrieved from http://www.cs.princeton.edu/~fiebrink/publications/Fiebrink_etal_ICMC2010.pdf

[2] http://www.iamas.ac.jp/~aka/max/

[3] http://www.osculator.net/

motes. A time-consuming solution was to individually pair each Wii-mote to their specific laptop one at a time.
With *What the Freq* the following year, a single instance of OSCulator running on an off-stage laptop paired all the Wii-motes and then distributed the control data to each individual laptop through Open Sound Control with MaxMSP. While this arrangement greatly reduced set-up time, wireless network lag affected the temporal connection between gesture and sound.

OSCulator's version 2.12-beta4, used in *What the Pluck,* allowed syncing of specific Wii-motes, eliminating the previous network lag and accidental cross pairing, as well as greatly reducing set-up time.

2.2. Posing and Mapping

Mappings for the Wii-mote were usually based off of borrowed performance motions from acoustic instruments. These borrowed performance motions were translated into basic 'poses' and gestures for each piece. The concept of poses was taking from the running training the composer was undergoing at the time of composition and used as a practice tool for musicians unfamiliar to the *What the What* works.

2.2.1. What the Bells

For the *What the Bells*, the sole gesture was based off of a hang bell ringing motion. I acknowledge efforts to codify vocabulary for musical gesture [2] with such systems like Gestural Descriptive Interchange Format (GDIF)[4] [3]. The directions for how to perform the gesture were delivered through demonstration and verbal instruction. The d-pad and joystick were mapped to the musical pitch. Each performer had two 'Wii-bells', each with a musical range of four semi-tones, increasing in semi-tone from Left to Down in a counter-clockwise manner.

The hand bell playing motion, a 'ring', actuated the sound when a wrist-flick at the end of the gesture caused the acceleration of the *pitch* to cross a certain threshold. Beyond that threshold, the loudness of the sound would increase with a greater acceleration value (performer wrist flick).

Performers quickly noticed that not all Wii-motes registered the same acceleration value from one Wii-mote to the next. One solution was found through programming and what I called 'bell tuning': each performer, prior to performing, would give a couple 'rings' that would expect a 'loud' resulting sound those acceleration values would set the maximum loudness. The programming, done through MaxMSP would scale the future acceleration values relative to 'bell tuning' maximum values. The use of this 'tuning' system continued through the rest of the *What the What* group.

[4] http://gdif.org/

2.2.2. What the Freq

What the Bells corrects issues regarding relative maximum acceleration values for a single performance gesture piece. *What the Freq* addresses the idea of varying performance gestures and poses. Shaker- and Agogo-playing motions were borrowed. The bell playing-motion is included as well as a new non-borrowed gesture.

To help performers remember the performance gestures, the laptop interface prompts them of both current and upcoming poses. (See Example 1.) From the image, the left hand performs the agogo gesture, rotating the rest. The roll values of the nun-chuck maps the actuation of the agogo sound. When the performer holds the Z-button and pronated/supinated their palm, an alternating agogo sound actuates. The right hand uses shaker performance motions. While the performer depresses the C-button on the Wii-mote, roll acceleration values beyond a certain threshold actuates a shaker sound.

A new performance gesture and pose (see Example 2.) was included in *What the Freq,* where performers must continuously rotate their wrists in any direction. While depressing the A-button on the Wii-mote and the C-button on the nun-chuck, the constantly changing roll values of the Wii-mote and the nun-chuck increase loudness on an additive synthesis drone. The immediate roll values (from both Wii-mote and nun-chuck) also dictates the frequency of the drones.

Example 1. Pose 2 for *What the Freq* shown on the laptop interface.

Example 2. Pose 3 for *What the Freq.*

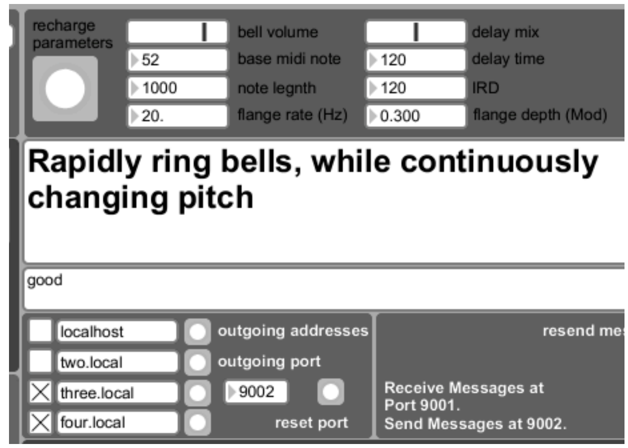
2.2.3. What the Pluck

What the Pluck departs from varying poses and gestures of *What the Freq* and returns to a single acoustic performance model: the cello. The borrowed performance gesture is modeled from plucking (*pizzicato*) of a string and bowing of a cello. The bow gesture maps the pitch acceleration value, when the Wii-mote is held on its side, to a scaled loudness. The pluck gesture maps the release of the B-button and the relative pitch acceleration of the Wii-mote together. In both the bow and pluck gestures, a very quiet sound actuate if the Wii-mote is not moving. A contribution to grouping is a more developed scaling method, where the non-linear scaling of acceleration values allows for a more expressive and musical possibility.

3. PERFORMANCE INSTRUCTIONS

Each piece in *What the What* uses a different performance instruction model. Each allow for different musical interpretations and inter-performer relationships. The shift from piece to piece in *What the What* moves from improvised text instructions to automated text instructions to traditional musical notation.

In *What the Bells*, a non-Wii-mote performer uses an on-stage laptop to type performance instructions. These typed instructions are sent through OSC to one, any, or all performers' laptop interfaces. A verbal instruction like 'Performer One: Create a melody' or 'Listen to Performer 3 and play a counterpoint' would then be interpreted by the performers. See Example 3. This instant message style performance instruction model allowed for improvised performance through the instructions. The open-ended interpretation of text and one-to-many performance structure allowed for the musical form to be visually opaque.[5]



Example 3. Performance Instruction on Laptop Interface for *What the Bells*

What the Freq's performance instructions are automated through the user interface on the laptop. Each individual performer receives unique text instructions. Compared to the performance information structure of *What the Bells,* this automated system allows for a stricter performance and also allows for a more practiced performance. An example of instruction is 'each play a note from Right to Left for the next 15 seconds'. While this method allows for a more practiced and coordinated performance, the automated system allows for a more varied and layered, independent performer relationship. Additionally, the pre-typed instructions are not slowed by a live instruction writer, who is limited by their typing capabilities. Upcoming instructions are shown on the user interface and time (in seconds) keeps performers aware of the future performance instructions. At the start of a performance of *What the Freq*, each performer starts their automations on their own laptop following a visual cue from a designated performer.

What the Pluck is a departure from *What the Bells'* improvised text instructions and implements a traditionally notated score for all performers. A conductor helps coordinate the time and advance through a few temporally indeterminate sections. Performers read typical musical notations such as pitches on a staff, dynamics, duration, articulation, *pizz.*, and *arco*. Performers are grouped in performance choirs, similar to a string section (Cello 1, Cello 2, etc.).

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[5] Compared to visually oriented improvisation or 'Conduction' pieces. e.g. Jeff Albert's *Forbidden Butch.*

4. CONTROL STRUCTURE

The control structure parallels the performance structure for each piece. With *What the Bells,* a one-to-many structure controls the synthesis parameters thats helps the piece deviate sonically from a clean FM-synth bell sound to a thicker, chaotic sound throughout the piece. An onstage non-Wii-mote performer uses an interface on an iPad using TouchOSC[6] to control modulation values, delay, feedback, and chorus. The instant message style instructions are typed on an interface written in MaxMSP. All the synthesis is on each performer's individual laptops through MaxMSP. The iPad controller's control information is routed through TouchOSC to the instruction-typing performer and then delivered to the individual Wii-mote performers' laptops, altering their sound. This orientation allows for individuals to control many performers at once and for performers, in their limited control, to focus on performative factors.

All the control data for *What the Freq* is stored and automated on each individual performer's laptop. Still, while the performers are free to actuate when, how loud, and from what pose they control the Wii-mote, some synthesis parameters remain restricted to the automation. This again allows for performers to focus on the inter-performer coordinated 'playing'.

In comparison, *What the Pluck*'s control structure is given completely to the individual performer. There is no external control data from other performers or non-performers. This gives complete freedom to the performer on *when* and *how* sound is made during a performance.

The control structure from piece to piece at first relies on a local area network to convey performance instructions and control data. The second piece only uses localized automated controls– with a cue starting the timed automation. The last piece has complete independence of control.

Though there is a progression in *What the What* from less to more individual control structure, no one model is particularly superior to another. Each provides their own performance freedom and control restriction. Performers are able to 'look up' and interact musically when interpreting a text instruction rather than focus on changing modulating indexes.

There were some technical difficulties encountered during the inter-laptop communications of the *What the What* progresion. Using Open Sound Control through UPD still required knowing the IP or network IDs. A solution was using Remy Muller's OSCBonjour[7] objects using ZeroConf networking protocol allowed for a speedier configuration.

The network lag previously mentioned for *What the Freq* was not fixed until the release of the OSCulator's 2.12-beta4 version. Using an individual laptop to pair and relay several Wii-mote control data to many other laptops was not a feasible solution. Also, OSCulator at the time was not able to pair with more than five Wii-motes. The solution is the use the beta release on individual laptops, where specific Wii-motes can be paired (and can ignore other Wii-motes).

5. COMPOSITIONAL FACTORS

Similar to the model of borrowing familiar gestures, all the pieces in the *What the What* collection begin with familiar sounds and idiomatic writing for those borrowed counterparts. Each piece draws on a common acoustic model: a bell choir, a percussion group, and a cello choir.

What the Bells explores FM-synthesis through improvised text instructions in a hand bell choir idiom. *What the Freq* explores several synthesis techniques with varying demonstrative performance gestures, allowing for a greater visual-sound connection. *What the Pluck* uses a solo cello to compare and contrast sampled and synthesis sounds from a Wii-cello choir.

6. CONCLUSION

The pieces in the *What the What collection* began as an exploration of laptop orchestra possibilities. The group as a whole relies on the use of Wii-motes and familiar acoustic performance motions. The examination of the pieces individually, for their technical difficulties and solutions addressing gesture mapping, instrument and time syncing, inter-laptop communication, performance and control structures, can contribute to expanding genre of laptop orchestras and ensembles.

7. REFERENCES

[1] Fiebrink, R., Trueman, D., Britt, C., Nagai, M., Kaczmarek, K., Early, M., Hege, A., et al. (2010). *Toward Understanding Human-Computer Interaction* in *Organised Sound*. Retrieved from http://www.cs.princeton.edu/~fiebrink/publications/Fiebrink_etal_ICMC2010.pdf

[2] Kvifte, T. "Towards a Coherent Terminology and Model of Instrument Description and Design" in *Proceedings of the 2006 International Conference on New Interfaces for Musical Expression (NIME06), Paris, France*

[3] Jensenius, A. "Towards a Gesture Description Interchange Format" in *Proceedings of the 2006 International Conference on New Interfaces for Musical Expression (NIME06), Paris, France*

[6] TouchOSC through Hexler.net

[7] http://recherche.ircam.fr/equipes/temps-reel/movement/muller/index.php?entry=entry060616-173626

USING LAPTOP COMPOSITION AND PERFORMANCE AS A PEDAGOGICAL TOOL WITHIN HIGHER EDUCATION

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ABSTRACT

Laptop ensemble composition and performance has been a core component of the Creative Music Production degree programme, and an optional component for the Popular Music and Music programmes at Manchester Metropolitan University for over 3 years. The teaching and the study of learner engagement with Laptop composition and performance at the institution is on going, but this paper will discuss both informal and formal observations made to date during the delivery and assessment of the work undertaken by undergraduate students.

1. INTRODUCTION

This paper details a case study on laptop composition and performance as a pedagogical activity at Manchester Metropolitan University. The topic of laptop composition and performance forms part of the class delivery of a unit of study called Electronic Composition and Sound Design for which, as an outcome, students have to produce a portfolio of formally assessed compositions. One of the compositions of the portfolio currently has to be a laptop composition realised in real-time. This paper begins by defining what is meant in this context as laptop composition and performance. Discussion is presented on the background and content of the classroom and assessment activities of the unit. The paper seeks to argue that the study of laptop composition and performance offers participating students the opportunity to develop core and transferable skills. Furthermore the paper proposes that documenting student development over the duration of the classes might potentially offer something to existing knowledge surrounding the genre.

1.1 A Definition

Although this paper discusses the approaches to Laptop composition and performance which involve an ensemble of laptop performers whom improvise material within a real-time based structural framework established by a composer (if you like), an attempt at apportioning responsibilities and roles within the ensemble, in this context is far from clear. First of all, and as will be discussed later, not all accept that improvisation is composition (and vice versa), and therefore the identification of just who is the composer within an ensemble of improvisers for some is not clear. Secondly, this paper, and the practice that informs it, inevitably has limitations. The use of the word ‘performance’ in this context refers to what we might call ‘real-time’ composition in a live context (whether that be classroom workshop or lunchtime sharing). Although the current topic of ‘liveness’ inevitably arises, at this stage of my research, this paper at best can only offer anecdotal evidence on how to counter what some perceive as the genre’s failure to engage with audiences during performances [17,1].

A definition of what is exactly we do as laptop composers and performers is problematic when a paradigm of the roles/relationships between performer, composer, audience and musical outcome seems yet to be clearly defined. Within this study it is difficult to separate the performance element from the compositional element. The ‘compositions’ happen in more or less real time, and are shaped by performance interactions, and therefore both are entwined in the musical outcome. I feel to use a definition where composition and performance may appear to be described as separate activities is not useful further than within the title of this paper. I have elected to use a more appropriate definition within the context of this study, and refer to the practice outlined in the paper, and from here on in, as ‘laptop music making’. I do not wish to impose this definition on anyone, anybody or anything else for that matter; it just suits my aims in the context of my work and this paper.

1.2 Background

Laptop music making has been an interest of mine since 2007, the year I established an undergraduate lunchtime ensemble that was the predecessor to the current staff led ensemble called MMULE[1]. The inclusion of laptop music making at undergraduate level at MMU fits in to our aims and objectives at year two and three within Electronic Composition and Sound Design. As exemplified in the following extract from the published unit summary, the possibilities for the latter unit content are quite broad,

> The unit…will consider a range of electronic music styles, and will allow the student to develop a portfolio of compositions [2].

[1] Manchester Metropolitan University Laptop Ensemble

At MMU the Creative Music Production course during year 2 in many ways diverts from the pathways many of the Popular music based students would normally follow into areas such as Electroacoustic composition and Algorithmic Composition. It is a year where students can embrace (or choose not to!) 'alternative' approaches to music making. As an emerging practice, laptop music making promotes the discussion of many of the current on-going topics related to electronic music production such as audience reception, language and interaction. Furthermore within the context of the ECSD[2] unit, students can explore on-going debates addressing improvisation within composition, or composition that includes improvisation.

Currently, the course and topical structure discussed here are based on my experiences as a laptop composer, improviser and performer. Although I have taken part and observed many of the satisfying structurally fixed networked and un-networked performance based work of other practitioners, my own work is based around the improvised generation of electroacoustic sound in real-time or as Landy calls Bowers' work, 'electroacoustic timbral improvisation' [14,156]. I also find structural parallels in my own approach to that of so called 'free' collective improvisers of the jazz idiom, in that my goals are to create 'laminal' or layered textures through the overlaying of the individual sound materials each individual performer of the ensemble contributes to the whole [6]. I also often hear within published electronic musical improvisation examples, including laptop music making, as it would appear Bowers [4,50] does, that the principals of Smalley's spectrormorphology and Emmerson's language grid are as pertinent here as they are to pre-composed acousmatic music. [19], [20], [8].

The focus of the ECSD unit inevitably explores the critical debate surrounding the relationship between improvisation and composition. In this context I consider the role of the person who provides the structure that guides the 'contingencies' of the improvised performance as the composer. Bowers has quoted some of Roseboom's views on improvisation within composition:

> My definitions for composition and improvisation are quite simple: A composer is simply, a creative music maker. Improvisation is simply, composition which is immediately heard, rather than subsequently heard. Any mixture of these is perfectly feasible. Creative music makers may include creative performers, composers, analysts, historians, philosophers, writers, thinkers, producers, technicians, programmers, designers, and listeners - and maybe most importantly, listeners [4,10].

Students in the ECSD class are expected to develop a composition that incorporates elements of live laptop improvisation. Much of class contact time is spent developing 'practically organised' frameworks for improvisation [4,2]. The 'composer', as we define her, sets out a framework of musical parameters, e.g. timbre, duration, dynamic, texture, instrument design etc., and it is within this framework that performers are expected to improvise and contribute to the development of the composer's ideas. This is not an unusual arrangement between composer and improviser. For example, whereas I have used the word framework, Ford In relation to the work he has done on free collective improvisation as a pedagogical activity in HE, uses the word 'plan'. He discussed how students must engage with 'one of their own, and one of another's plans…' for the execution of the practical element and musical outcomes of his course [11,109]. In the ECSD sessions, the 'contingencies' of the performance usually reside in the interaction the frameworks afford between each performer, and also the performers and the composer. In the discussions that follow practical work some ECSD students clearly consider what has passed as composition, and furthermore many students appear to consider '…as many artists…' do, that 'improvisation should be seen as synonymous with composition' [14,155]. Understandably, not all laptop practitioners share this view. For example consider Ogborn's clear differentiation between composition and improvisation in this description of the activities Cybernetic Orchestra.

> The day-to-day practice of the Cybernetic Orchestra emphasises performance and improvisation over composition, although the orchestra does perform fixed compositions created outside of the weekly rehearsals [16, 56].

Despite their sometimes considerable contribution to the musical outcome of each composer's framework, and unlike Prevost quoted in Bowers below, MMU students rarely have any remarkable objections to the composer being attributed the credit for the musical outcome or 'composition'.

> Conversely, when composers include passages that are not specific in pitch, position or movement, then they are being dishonest if they do not acknowledge the creative contribution of the improvisers. In such cases the musician should be treated as co-creators and co-copyright holders! [4,7].

Instrument design and interaction are recurrent issue during the short run of this topic within the unit. Students are asked to discuss the outcomes of the practice-based workshops they take part in and inevitably have to explore the limitations or opportunities their instruments offer to their interaction with the compositional framework outlines and also with other member performers. Over a series of classes they are all able to take a turn at the roles

[2] The unit title acronym for Electronic Composition and Sound Design

of composer, performer and audience member.

As resources are limited we begin by exploring Logic Studio 9 as a live performance tool utilizing the audio DSP aspects of its functionality and using either QWERTY keyboards and a Mouse, or MIDI hardware to send and receive control messages. We use Apple Imac computers rather than actual laptop computers. Useful results can be achieved through the latter set-up, but later we also use MaxMSP to develop and refine further ideas for instrument and interactive design. MaxMSP allows the students to utilize alternative controller types such as joystick gaming controllers.

Interaction between performer, composer and audience is further explored through the discussion and experimentation with the spatialisation and projection strategies. We incorporate discrete instrument design with the use of a satellite speaker or built in speaker, and also explore the use of a collective ensemble projection through the use of summing into stereo loudspeakers. Interaction between participants is a lively topic during these sessions, and often includes debates on the most effective way of delivering performance instructions to performers.

2. THE STUDY OF LAPTOP MUSIC MAKING

2.1 What can the study of laptop music making offer to existing knowledge surrounding the genre?

In terms of contributing to existing knowledge, the time period the topic runs within the unit is framed by early and consequent discussion of Laptop music making as performance and composition activity. As discussed later students do, initially at least, have difficulty with the lack of visual clues to the sound making activities of Laptop music making. There seem to me to be clear parallels between the reception of acousmatic music and the reception of live electronic music, including laptop performances. Although in Acousmatic music causality is more often than not intentionally removed leaving for some only relationships between sound and imagined agency, for me the often lack of gestural connection between sound and performing activity within Laptop music making means that the acousmatic curtain is unintentionally lowered during performances leaving only the sound to be considered. According to Emmerson some composers and performers of live electronic music seem intent on immersing the visual in favour of creating what appears to be an acousmatic context. On Electroacoustic music for 'tape and 'live' instrumentalist he says, '[o]ne tradition of instrumental amplification in mixed music concerns pieces in which the instrument 'aspires to the condition of the acousmatic' [9,105]. Emmerson also quotes Matthews discussing live electronic performances pointing out that 'All I wanted was for people to turn their eyes off and get down to some listening. "No, theres nothing to watch here!" [9,112]

Considering the above, Laptop music making as a contemporary arts practice might well benefit from a research enquiry similar to those conducted by acousmatic practitioners such as Weale (2005) [22] and Landy (2007) [14], This is something others including Moore have commented on,

> Clearly more research on the social and communicative aspects of laptop performance is required and it is quite clear that in the West, our understanding of composing, performing and listening, and the socio-cultural activity of paying for participation in a concert as an audience member is deeply rooted in our experiences of rock and classical music. The question 'what is the experience of a laptop performance?' drew upon research conducted at Leicester DeMontfort University on intention and reception in contemporary sound-based music [15, 3].

Furthermore other ideas on how this study of laptop music making might contribute to existing knowledge have been drawn from a study by Higgins and Jenkins, where practical participation appears to help educate and promote engagement with Electroacoustic listening [13]. Their study on young listener's reception of Electroacoustic was approached through a methodology made up of a series of Electroacoustic composition exercises. Where students 'construct their understanding through doing' [13,179]. The impact these exercises had on the participants engagement with Electroacoustic art was discussed in their findings. During the classes at MMU, student attitudes to laptop music making at the start of the course and at the end are monitored during student discussion and through student feedback. In a general sense it could be argued that the classes are attempting to reveal '…something of the technology…' to the students and in doing so might help prepare the students for further and hopefully more rewarding contact with the genre by empowering them in a way that they might '…understand when and how something special is occurring' [14,155].

With reference to d'Escriván assertion on post 1980s listeners, Croft has outlined that there are some practitioners who feel that the removal of firm gestural clues to the sounds and musical outcomes of live electronic making are not problematic for many listeners.

> …the demand for a connection between bodily effort and acoustic output is a form of nostalgia for a traditional form of musical performance; listeners who are not subject to such nostalgia have no problem with effortless, invisible performance: [5,63].

In the early weeks of my class series, I have found no real indication that MMU undergraduates do not seek the 'nostalgia' outlined in the above quote. It could be argued that observing the attitudes of students to laptop music

making both pre, during and post the learning activities of this unit might reveal something of use to the genre as a whole.

A number of writers on subject of the sound art, be it laptop music making or electroacoustic music, seem identify a usefulness in the role of pedagogy in the reception of sound based art. This is clearly not just at the level of HE as Regelski's points out in the following statement.

> Thus, a pedagogy in schools and universities that includes a significant role for organised sound pieces will, in this regard, begin to open minds and ears to the possibilities of music that go well beyond the limitations of conventional aesthetic doctrine and the 'great works' of the musical museum [18,40].

2.2 What can the study of laptop music making offer to HE students and pedagogy?

Finally, of course we should not consider just what pedagogy can offer the field of laptop music making, we should consider what Laptop music making can offer to pedagogy at the level of HE. As I will discuss later and certainly at MMU, the context in which we consider Laptop music making, makes it an ideal tool from which students can develop core subject related skills. Furthermore, and again as discussed later laptop music making is also an ideal pedagogical tool/ resource from which students can develop some very useful transferable skills. A discussion of the attainment of skills will follow some examples of classroom activities.

3. "ITS A BIT LIKE WHISTLING. ITS ONLY FUN FOR THE WHISTLER" – CLASSROOM ACTIVITIES

The weekly contact, which guides student self-study time, consists of a number of tasks managed by the lecturer. The following are some brief examples of what class delivery has contained.

3.1 Week 1

The introductory week is spent reviewing some videos of laptop orchestra performances and compositions from around the world.[3] Students are asked to review the video clips and after group discussion, feedback to the group as a whole on their opinions of the material shown in the clips. At this stage of listening, albeit via recorded clips as source material, students comments often become pre-occupied with two main elements: 1) The lack of visual stimulus – leading to problems with engagement and also mapping effort to output; and 2) their inability to discern clear musical structure and syntax within the source material. Week 1 concludes with an improvisation workshop. After a practical 'how-to' demonstration, students are asked to create a digital instrument using Logic Studio 9, a provided audio sample and the plugins bundled with Logic Studio 9. A basic performance plan is given to students to realise. The plan content gives no other requirements other than they should create electroacoustic timbres over a given duration. After the latter workshop exercise has taken place, I initiate a debate on what has happened and get students to discuss their thoughts on the process.

This year and in years gone by, the most striking thing for me is that the students always express a sense of satisfaction in taking part in the exercise rather than listening only. I would say that I myself in past performances have felt a sense of what apparently John Zorn's improvisers have described as cathartic release and I am of the opinion that students who actively engage may be experiencing something similar [11,107].

From a pedagogical perspective, it is perhaps no surprise that, for students, taking part in the creation is more appealing than participating as a listener only. However, going beyond "It's a bit like whistling. It's only fun for the whistler", as one student commented, other students gave constructive comments on both the musical structure that evolved from the exercise, and also on the interaction which had occurred between performers within the ensemble. Over the coming week students are asked to develop some ideas to counter the shortfalls and build upon the strengths of the week 1 workshop.

3.2 Week 3 – exploring limitations

During week 3 students are expected to demonstrate a more developed sense of delivering the performance instructions of their framework ideas. They have been exposed to ideas such as John Zorn's Cobra and textual approaches to networking between performers [12]. As a class we explore musical interface design by mapping MIDI hardware controller controls to the software of their workstation. In this week we complete our exploration of Logic Studio 9 as a laptop music making tool by exploring gesture through the use of the software 'scrub' features. In subsequent weeks we move onto designing instruments using MaxMSP and gaming joysticks.

4. "CAN YOU GUARANTEE THAT AFTER THREE YEARS OF STUDY ON A MUSIC RELATED DEGREE MY DAUGHTER WILL NOT END UP WORKING IN A WELL KNOWN FAST FOOD RESTUARANT?"

4.1 Core and transferable skills

[3] Specific examples this year included The Cybernetic Orchestra (2011); The Oslo Laptop Orchestra (2008); Moscow Laptop Orchestra (2007); and the Berlin Laptop Orchestra.(2007)

With so much of the laptop orchestra and live electronic music paradigm to be agreed, we might considered that Ford's statement on free collective improvisation is also applicable to laptop music making.

> If free improvisation follows no rule or principle, it would seem to promise no pedagogic function, since it can offer no criteria for assessment [11,104].

What rules and principals are there to a Laptop orchestra performance or to a Laptop orchestra composition for that matter? Moore's report on an event held at the University of Sheffield includes evidence of the ongoing debate into what the Laptop orchestra paradigm might be. On the afternoon debate chaired by Simon Emmerson he says,

> Debate began by discussing the experience of laptop performance and the 'performance environment'. Participants were reminded that there were no right or wrong examples but that each example created numerous consequences [15,4].

If there are no 'right or wrong examples' then how can the study of Laptop music making 'promise' any pedagogic function? Within his study Ford defends the study of free collective improvisation in Higher Education by outlining its pedagogic function.

> I want to argue that such practices are of great value, not only for the sake of students' musical education, but also for their general ethical development, and, via the fashionable notion of 'transferable skills', for their vocationally relevant outcomes [11,104].

I personally feel that the study of laptop orchestra music making offers undergraduates much in the way of core music skills. At MMU some students do occasionally have to be reminded of the benefits of their endeavors! Discussion of how experimental approaches to composition can inform and contribute to the development of core skills is discussed at the start of the weekly class runs.

For UK Higher Education institutions transferable skills was not only a 'fashionable notion' in 1995, but it has remained on the pedagogical agenda since (probably before) and even more so in current times. The new fee system to be introduced to new undergraduates from September 2012 and the UK Government's public call for the HE sector to focus on the employability of their graduates, means that many educators, perhaps even more than ever, find themselves having to develop their curriculum based not only on core skills, but on the identification of transferable skills or what is sometimes referred to as employability skills. I myself find much of my undergraduate recruitment duties are spent explaining to potential recruits, and more so their parents these days, what core and transferable skills students will develop during their studies, and how this will endow them for the graduate world afterwards. The notion of transferable skills was high on the agenda in 2008 when NAMHE, the National Association for Music in Higher Education and PALATINE, the Higher Education Academy Subject Centre for Dance, Drama and Music, commissioned a report into the topic of transferable skills within the Music degrees of the UK HE sector. The rationale was given in the report as follows,

> There is no denying the growing responsibility HE institutions have to ensure that students are prepared for post-university careers. By presenting Higher Education music courses in terms of their ability to offer potential employability, partly through the acquisition of transferable skills, music academics help to validate music's place within the academy, alongside other discipline areas [7,1].

The following statement from later in the report offers more rationale for the report.

> To retain music's existence alongside other degrees, it is vital that subject specific, and non-subject-specific skills, such as transferable skills, are identified and used in the promotion of courses [7,9].

According to Dockwray and Moore, in 1997 in *Higher Education in the Learning Society - Report of the National Committee of Inquiry into Higher Education*, Dearing suggested the four most important transferable skills are:

- communication skills;
- numeracy;
- the use of information technology;
- learning how to learn. [7]

More recently in the UK the list has been expanded in the following way by the graduate employment website www.prospects.ac.uk (2012)[4] –

- communication;
- teamwork;
- leadership;
- initiative;
- problem solving;
- flexibility/adaptability;
- self-awareness;
- commitment/motivation;
- interpersonal skills;
- numeracy. [23]

There are many obvious links between Laptop music making and the development of core and transferable skills. I have attempted to evidence them in a similar way

[4] In this second list Information Technology appears to part of communication. '…via electronic means, in a manner appropriate to the audience'

to the Dockwray and Moore report with key phrases as follows[5] [7].

Transferable Skills	Laptop music making
• communication skills;	performance instructions; performance interaction (Performer – Performer > Audience).
• numeracy;	programming; compositional strategies.
• the use of information technology;	programming; Instrument design.
• learning how to learn.	contextualisation; research and reflection.

Table 1. Evidencing the four most important transferable skills listed by Dearing. [7]

Transferable Skills	Laptop music making
• communication;	performance instructions; performance interaction (performer – performer > audience).
• teamwork;	ensemble interaction.
• leadership;	composer/conductor.
• initiative;	organizing self study activities e.g. rehearsals.
• problem solving;	composition; Instrument design.
• flexibility/adaptability;	responding to composer.
• self-awareness;	listening & contributing
• commitment/motivation;	realisation of musical ideas
• interpersonal skills;	communicating with ensemble members
• numeracy	programming; compositional strategies

Table 2 – Evidencing of transferable skills listed on the Prospects website (www.prospects.ac.uk) [23]

I feel there are some transferable skills that deserve a further brief discussion. For example we might consider the development of numeracy through the study and practice of laptop music making. Dockwray and Moore listed composition work as evidence of the development of numeracy as a transferable skill. In addition to the latter some approaches to Laptop music making can require advance mathematical understandings – for example through the manipulation of numerical data within MaxMSP [7].

There is also a number of communication based transferable skills that Dockwray and Moore have listed and evidenced in a traditional music degree context, but these again are perhaps further explored within the topic of this study. For example, whilst music students may well have to communicate ideas through traditional score based medium, students who engage in laptop music making as of yet have no universally established specific way of communicating musical ideas and have to devise forms of communication in order to relay ideas and interact with ensemble members. The challenges of developing a suitable system for communication can arguably be much more demanding.

Another example I feel warrants further discussion is the development of Information Technology skills – which notably, at the moment, is also highly visible as a topic within education sector in the UK. Within the study and practice of Laptop music making I would argue that IT skill development can be much more rigorous than the basic level demands of using software package such as using Word or PowerPoint. Understanding latency and hardware drivers in the context of Logic studio as a performance tool encourages students to understand 'what is under the bonnet' so to speak. Manipulating numerical data in MaxMSP or creating a buffer for the playback of an audio sample in MaxMSP can encourage students to explore computer architecture. Furthermore, laptop music makers have probably all been in the position of having to solve a computer problem either just before or during a performance. It is hard to imagine being able to do this without having more than a basic understanding of the workings of a computer and the software being used.

If we consider recent debate on IT provision in the UK education sector, some writers such as Martin Eve are looking towards discussion occurring in the USA.

> We shouldn't waste time teaching students basic IT skills. University students should already know how to use Microsoft Word and PowerPoint. The real gains are in being taught programming… In recent days, several sources, primarily in the US, have suggested that all undergraduates should be taught computer programming [10].

[5] There is a far more exhaustive list of the transferable skills of Music degrees and how they are evidenced in (Dockwray and Moore 2008)

Furthermore on current IT training outside of core specific provision for IT, Eve quite scathingly says,

> In all disciplines, though, from physics through to philosophy, we are teaching students useless, proprietary IT skills. Indeed, I am sceptical whether we can call using Microsoft Word and PowerPoint a "skill". It's more a prerequisite to existence in contemporary society and belittles the "higher" of higher education; few would call basic arithmetic a skill at this level. Understanding computer programming gives insight into how programs are designed and teaches a student to fish – that is, to understand how a structure might apply in any program they use – rather than being given the Microsoft carp [10].

The Secretary of State for Education, Michael Grove has been critical of IT provision in schools, calling for a return to computer science. [1] One the accepted problems within ICT provision in schools is a lack of specialist teachers. I am not suggesting that the study and practice of Laptop music making will create a new generation of programmers, but it may create an interest and a might yield a much more useful depth of transferable IT skill. My own first encounter with programming came through post-graduate study. The transferable skills developed through creating programs in C to manipulate sound files and MIDI have been some of the most useful I have acquired to date.

Finally on transferable skills as side product of the study of laptop music making, I think it appropriate to mention that transferable skills are not only useful for gaining employment, but are of course important for life in and outside of work.

> While transferable skills are linked to potential employability, the skills developed are not exclusive to employment and are important in other aspects of work and life [7,3].

5. JUST HOW DO YOU AWARD LAPTOP MUSIC MAKING?

5.1 Background

Within a pedagogical context establishing an appropriate assessment task and a set of appropriate assessment criteria to assess student learning and skill development is clearly part of effective curriculum design. Bloxham and Boyd's outline of the skills that ideally need to be addressed within HE assessment criteria can be summarized as follows:

> Development of knowledge and understanding (subject specific); Cognitive/intellectual skills (generic): application; Key/transferable skills (generic): communications [3, 183].

Furthermore, when developing unit assessments, consideration should be made to ensure students can clearly grasp the relationship between the assessment task and the class-time preparation they have engaged with. There should also be a clear and useful relationship between the assessment task and the assessment criteria the student work will be assessed against.

> Students value assessment activities which appear worthwhile in themselves; they appear to have value beyond completing the task (Struyven et al. 2002) [3, 27].

The starting point for assessment tasks and criteria has to be the establishment of a task or tasks that can be clearly mapped to the aims and objectives of the course. In a creative music based unit the obvious kinds of task are musical outcomes. However Ford found difficulty with assessing the musical outcomes of the free collective improvisations his students regularly took part in during class sessions and as a directly assessed activity. On this he says,

> Free improvisation, especially with mixed ability groups, poses a problem for assessment, since it is virtually impossible to establish criteria for performances [11,109].

Joint student group assessment at MMU has on occasions proved to be problematic. This is often due to the varied amounts of engagement individual students wish dedicate to groups assignment and assessment, and also that the student body is made up a broad range of experiences. Ford outlined his solution in the statement below where he says,

> My solution to these problems is to keep assessment well away from the practice of improvisation. I ask students to produce three performances…. I assess students on the basis of three short essays, each concerning one of their own, and one of another's plans and their realisations. At the end of the course they also write a longer, general essay about the nature of free improvisation and their general experience of their particular group. So I assess not improvisations, but thoughts about improvisations, be they philosophical, political, moral or aesthetic [11,109].

It is difficult to hypothesise on the merits of Ford's assessment task, as although the task for submission is an essay, a practical endeavor in itself, the topic of the essay has to be based on engagement with three practical performance experiences. Therefore although students are not directly being assessed on their 'compositional' frameworks or 'plans' in which others participate, I can only assume that the level of engagement in the practical element that forms the discussion of the resultant essay has to be high to get a good award for the submission. However I would guess that the assessment criteria and

subsequent assessment feedback in Ford's model would inevitably have to address the strengths and areas for development within the essay submissions rather than the musical realisations themselves. In a more modern context, I tend to agree with Bloxham and Boyd's summary of assessment design within HE.

> Assessment strongly influences students' learning, including what they study, when they study, how much work they do and the approach they take to learning…Well designed assessment is likely to be intrinsically motivating for students and lead to better retention of material which students can apply in other settings [3, 29].

I feel MMU students, like many UK based HE students, tend to engage with the elements of their courses for which they are to be assessed. In Ford's model, MMU students would probably be more engaged with learning to write an essay rather than the practical elements that would inform the content of the essay. This is not to say they would not engage in the practical aspect, rather they would concentrate their efforts on producing the essay itself.

There are some documented studies of pedagogical activities within 'high art' based sound organization to draw experience from. Higgins and Jennings study of the Electroacoustic listening of 16 year olds appears to have been an extra curricular activity with no formal assessment point [13]. Participants were asked to undertake a number of Electroacoustic composition tasks and discuss and evaluate their own work and experience of participating. The authors make clear that their study aims were to observe the development of their participant's Electroacoustic listening skills.

> The study did not set out to create composers but to give them some tools for listening purposefully [13,185].

Wang et al have documented the pedagogical activities surrounding the Princeton Laptop Orchestra (PLOrk). Examples of PLOrk assessment activities include to build and perform a 'generative drum machine' and to 'design an ambient soundscape' [21,32]. These assessment tasks appear to have a clear relationship to the content delivery outlined in the same article. Exactly what the assessment criteria were is not made explicit in the article itself, but some interesting comments on their approaches are made.

> Although we require that students learn enough programming to complete the assignments, we do not explicitly require that students achieve any particular level of proficiency in programming during the semester. We do, however, require that the end product of sound, music, and performance be interesting, thoughtful, and in accordance to specification. The programming language is to be used solely as a tool, a means to realise the tangible and rewarding goals of music creation, and not as an end in itself [21, 30].

I find this approach appealing as I think would the Popular music students of our classes at MMU. It appears to promote the aesthetic over the technical, and recognizes that complexity in process does not always yield satisfying musical outcomes.

The context of study at MMU, and arguably in the UK HE sector overall, is that we have to consider the delivery and assessment of core and, as I have discussed, transferable skills. Bloxham, Boyd have pointed out that within the UK,

> …the employability and graduate skills agenda is placing pressure on tutors to design assignments and examinations which assess a much broader range of achievement than in the past. Assessment is now expected to assess subject knowledge and a wide range of intellectual, professional and generic skills in a quality-assurance climate that stresses reliability with robust marking and moderation methods [3,4].

5.2 An assessment task

For the laptop music making assignment, during the assessment period, students are expected to realise each others framework, which forms the basis of the practical musical outcome and 'composition'. Each composition is assessed in real-time during the performance and assessment is made of the resultant sound and not the visual aspects of the realisation.

5.2.1 Assessment criteria

The establishment of assessment criteria for this unit began with consideration of the unit learning outcomes and assessment materials as published by MMU. The most appropriate learning outcomes with regard to the Laptop music making as part of their portfolio are shown below.

> On successful completion of this unit students will be able to have attained or demonstrated:
>
> 1) confident use of a range of music software packages and hardware systems
> 2) a developed understanding in applying creative strategies in the development of practical work [2].

For the purposes of the ECSD unit I created a set of generic assessment criteria that considers all the above, and can be mapped to practical laptop music making and also the other practical elements from within the unit which fall outside of the topic of this paper:

> 1. Technical competence with software and hardware equipment.
> 2. Application of DAW techniques to realise creative ideas

3. Ability to develop critically stylistic and suitable materials
4. Appropriate assignment presentation [23].

Assessment criteria element 1 considers the student's ability and competency in organizing their instruments for their realization. Element 2 considers the student's implementation of the equipment in order to achieve creative ideas – the point here is that implementations can be at any level of complexity – the actual creative outcomes and the suitability of techniques applied in order to achieve the desired creative outcome are the subject of this assessment element. Element 3 considers the students overall musical outcome in the context of stylistic appropriateness. Put simply, can the student produce materials that are appropriate to their experience of the genre? For example, whilst a student in relation to element 2 might demonstrate creative ideas in terms of application of DAW techniques, the overall musical outcome might not sit well with guidance on the existing canon. Element 4 considers the presentation of student work. In this particular assessment instance students have to realize their work in a real-time performance scenario to class members. They then submit a live recording of the latter on an audio CD. The presentation award is based on the unit and university guidelines on submission, and how well the students follow them, and is not based on the visual implications of their realisation.

We publish all the criteria at the start of the unit run and deliver feedback in two ways. All students receive a formal mark sheet with a percentage mark and an indication of marking 'band' to which level their work is considered appropriate to [3,93]. Students receive detailed personal feedback in the form of a Podcast.

6. TANGIBLE OUTCOMES

Whilst students attaining credit towards their overall degree is a priority to all involved in the unit, as mentioned, I like to attempt to gauge students attitudes to the laptop music making by engaging them in discussion at the start, during and at the end of the lecture and assessment run. Whilst I can claim no real 'science' or methodology to the survey of before and after views, students appear to respond positively to the topic and seem to demonstrate a more 'developed' sense of the genre. This can be demonstrated in the actions of some students who since, or even during, the lecture series have visited and taken part in externally organised laptop music events. Some students go on to further develop the areas covered in this section of their studies, including further assessed work as part of their final year at undergraduate level. The following are some quotes from students:

> 'I've been very interested in laptop music since. In fact after the unit I've pretty much done nothing else since. All my compositions have been laptop based with sampling and using software like PD, max/MSP etc.'
>
> 'After my undergraduate studies are completed I intend to do a masters in laptop composition.'
>
> 'I enjoyed the roles of performer and composer and would be more than happy to repeat the process, should the opportunity occur.'
>
> 'I had not come across Laptop composition and performance before and it opened up a whole new way of making and performing music.'

There are no negative responses to be shared, but not all students choose engage in the discussion and this might well be because these students did not enjoy the experience and do not want to make any negative comments.

As mentioned earlier the above responses can offer little more than anecdotal evidence to argue that pedagogy can help develop the genres accessibility. Creating as Landy puts it a 'knowledgeable public' 14,155]. Higgins and Jennings found that practical engagement with Electroacoustic Composition helped to develop the Electroacoustic listening skills of the 16 year olds participants of their study [13]. Given the similarities between the presentation and timbral content of Electroacoustic music, and the type of laptop music making that has been discussed here, we might argue that initial findings warrant further controlled studies. Further study might take a similar approach to that of Higgins and Jennings, or might adapt the approach Weale [21] and Landy [14] have used. In the case of the latter, programme notes alongside details of the technology involved in each piece might be progressively revealed to listeners during the study.

As mentioned earlier, this study has sought to outline ideas on how pedagogy is useful for the development of the genre itself, but also to demonstrate that the teaching and assessment of a topic such as laptop music making, delivers to HE students, not only core subject specific skills, but also considerable transferable skills.

REFERENCES

[1] Belshaw, D. "Resurrect computer science – but don't kill off ICT," in The *Guardian,* January 2012. http://www.guardian.co.uk/higher-education-network/blog/2012/jan/24/digital-literacy-in-school

[2] Blain, M, Fairhall, A, Shrubsole, G, Woolley, J. *Musics Undergraduate Network Definite Document.* Manchester Metropolitan University, 2009.

[3] Bloxham, S. Boyd, P. *Developing effective assessment in higher education: a practical guide*. Open University Press., UK, 2007.

[4] Bowers, J. *Improvising machines: Ethnography Informed Design for Improvised Electro-acoustic Music.* ARiADA 4: www.ariada.uea.ac.uk , 2003. (last accessed 15.2.12).

[5] Croft, J. "Theses on liveness" in *Organised Sound* 12(1):pp 59–66. Cambridge University Press, 2007.

[6] Dean, R, Smith, H. *Improvisation, hypermedia and the arts since 1945*. Harvard Academic Publishers, 1997.

[7] Dockwray, R and Moore, A. *Evidencing Transferable Skills in Undergraduate Music Education.* http://www.namhe.ac.uk/publications/reports/transferable_skills.pdf , 2008.

[8] Emmerson, S. "The Relation of language to Materials" in Emmerson, S (ed.) *The Language of Electroacoustic Music*. The Macmillan Press, London, 1986.

[9] Emmerson, S. Living Electronic Music. Ashgate, Aldershot UK, 2007.

[10] Eve, M. "We shouldn't waste time teaching students basic IT skills," in *The Guardian,* January 2012. http://www.guardian.co.uk/higher-education-network/blog/2012/jan/12/teaching-students-basic-it-skills

[11] Ford, C, C. "Free collective improvisation in higher education," in *British Journal of Musical Education* 12, 103-112. Cambridge University Press, 1995.

[12] Freeman, J Van Troyer, A. "Collaborative Textual Improvisation in a Laptop Ensemble," in *Computer Music Journal* 35:2 pp 8-21. MIT Press Journals, 2011.

[13] Higgins, A-E, Jennings, K. "Peering in the Window to Opening the Door: a constructivist approach to making electroacoustic music accessible to young listeners," in *Organised Sound* 11(2): pp 179–187. Cambridge University Press, 2006.

[14] Landy, L. *Understanding the Art of Sound Organization*. Cambridge, Mass: MIT Press, London, 2007.

[15] Moore, A. "INTERACTIVITY IN THE PERFORMANCE OF ELECTROACOUSTIC MUSIC," http://www.methodsnetwork.ac.uk/redist/pdf/act34report.pdf, 2007. (Last accessed 17.2.12)

[16] Ogborn, D. "Composing for a Networked, Pulse-Based, Laptop Orchestra," in *Organised Sound* 17: pp 56-61. Cambridge University Press, 2012.

[17] Paine, G. "Towards Unified Design Guidelines for New Interfaces for Musical Expression," in *Organised Sound* 14(2): pp 142-155. Cambridge University Press, 2009.

[18] Regelski, T, A. "Sound compositions for expanding musicianship education," in *Organised Sound* 7(1): pp 29–40. Cambridge University Press, 2002.

[19] Smalley, D. "Spectro-morphology and Structuring Processes" in Emmerson, S (ed.) *The Language of Electroacoustic Music.* The Macmillan Press, London, 1986.

[20] Smalley, D. "Spectromorphology: explaining sound-shapes," in *Organised Sound* 2(2): 107-26. Cambridge Journals, Cambridge, UK, 1997.

[21] Wang, G. Trueman, D. Smallwood, S. Cook, P. "The Laptop Orchestra as Classroom," in in *Computer Music Journal* 32:1 pp 26-37. MIT Press Journals, 2008.

[22] Weale, R. "Discovering How Accessible Electroacoustic Music Can Be: the Intention Reception project," in *Organised Sound* 2(2): 189-200. Cambridge Journals, Cambridge, UK, 2006.

[23] Woolley, J. *Electronic Composition and Sound Design Unit Handbook.* Manchester Metropolitan University, 2011.

Web resources

[24] http://www.prospects.ac.uk (Last accessed 17.2.12)

[25] The Oslo Laptop Orchestra (2008). http://www.youtube.com/watch?v=0TMCyCz4nKo (Last accessed 17.1.12)

[26] The Cybernetic Orchestra (2011). http://www.youtube.com/watch?v=fWRB4A4Csjg (Last accessed 17.1.12)

[27] Moscow Laptop Orchestra (2007). http://www.youtube.com/watch?v=4Q45et5IMMM (Last accessed 17.1.12)

[28] Berlin Laptop Orchestra.(2007). http://www.youtube.com/watch?v=2Zx8BOKmBiw (Last accessed 17.1.12)

FROM SCHAEFFER TO *LORKS: AN EXPANDED DEFINITION OF MUSICAL INSTRUMENT IN THE CONTEXT OF LAPTOP ORCHESTRAS

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ABSTRACT

Departing from Schaeffer's definition of musical instrument, this paper identifies three other relevant non-sonic aspects that may be useful in the context of laptop orchestras: presence (the body of the instrument and the human body as shaped by it), movement (the instrument and the human body in motion), and history (the historical repertoire and cultural surroundings attached to the instrument). In the context of the laptop orchestras of today (such as PLOrk, SLOrk, L2Ork, just to name a few), Schaeffer's ideas continue to offer interesting insights in instrument design; however, since laptop ensembles aspire to provide the audience with a meaningful non-acousmatic listening situation, there arises the need for a practical definition of musical instrument beyond a strictly acousmatic point of view. Two concrete examples of recent pieces performed by the Stanford ensemble are offered at the end to illustrate the discussion.

1. INTRODUCTION

This paper comes from my own experience as a "laptop performer," and particularly from my experience composing and performing with SLOrk, the Stanford Laptop Orchestra. Departing from Schaeffer's definition of musical instrument, I propose to explore three additional aspects that may prove useful in the context of laptop orchestras. I will illustrate the discussion at the end with two concrete examples of recent pieces performed by SLOrk.

2. THE LAPTOP AS A META-INSTRUMENT

A typical player station in laptop orchestras such as PLOrk (Princeton University) and SLOrk (Stanford University) comprises computer, speaker, and accompanying gear such as audio interfaces and meditation pillows. The term "meta-instrument" has been used to describe these player stations, reminding us of the open-ended nature of a laptop [11] [12]. On the same issue, the electronic musician Robert Henke (aka Monolake) has the following to say:

The laptop itself does not contribute anything by its own. (...) What makes it an instrument is the software running on it. (...) The laptop is not the instrument, the instrument is invisible. (...) What really happens and what remains completely non-decodeable for the audience is more described as a huge number of instruments played by an invisible band sitting inside the laptop. The only visible part is the performer conducting the work in a way which looks extremely boring in comparison to the amount of physical work carried out by the guy forcing a full blown orchestra of stubborn professional musicians through a symphony. The minimum difference between pianissimo and a wall of noise? One pixel, 0.03mm. [4]

Throughout this paper, I will consider a laptop-mediated instrument to be any combination of software and portable computer hardware that is musically offered to human performers to play.

3. SCHAEFFER'S DEFINITION OF MUSICAL INSTRUMENT

In his Treatise of Musical Objects, Pierre Schaeffer defines a musical instrument in the following way[1]: "Any device that allows us to obtain a varied collection of sound objects—or varied sound objects—keeping at heart the permanence of a cause."[8]

The core of Schaeffer's definition is the balance between permanence and variation. It is important to note that the focus is on the sound itself, not on how the sound is produced. This makes sense from a purely acousmatic point of view. A collection of correlated sounds perceived as coming from one same source can make one believe in the existence of an invisible musical instrument, a single plausible origin for those sounds.

Michel Chion, in his book Guide of Sound Objects [1], attempts to clarify and break down Schaeffer's definition. According to Chion, permanence is mainly sustained through timbre, a kind of abstraction resulting from the perception of all other charateristics of sound in association. Variation, on

[1] My translation. This is the full quote from the original in French: "Tout dispositif qui permet d'obtenir une collection varie d'objets sonoresou des objets sonores varis—toute en maintenant l'esprit la permanence d'une cause, est un instrument de musique, au sens traditionnel d'une xperience commune toutes les civilisations."

the other hand, are changes in the sound that can be either abstract or concrete. An example of abstract variation is the tempered scale one can obtain from a vibraphone. An example of concrete variation is the difference between pizzicato and arco on a string instrument.

This last example brings us to interesting borderline cases. It is not by sonic similarity that we are able to file under "violin" sounds as disparate as the pizzicato and the sustained bowed note. Similarly, in an acousmatic situation, an untrained listener may justifiably confuse the sound of a prepared piano with that of a gong. In short, concrete variations already "crack open" any idealized unity of a musical instrument based solely on sonic criteria. Since laptop ensembles aspire to provide a meaningful non-acousmatic listening experience, one needs to go beyond a strictly acousmatic point of view.

4. EXPANDED DEFINITION OF MUSICAL INSTRUMENT

I propose to consider three other aspects that are not contemplated in Schaeffer's immediate definition: presence, movement, and history.[2] These categories can be easily understood in the context of acoustic instruments, and hopefully will also be useful in the consideration of laptop-mediated instruments. Please note that this is not supposed to be a comprehensive list of possible categories.

4.1. Presence

Presence involves the intrinsically visual and theatrical presentation of the instrument: its physical body, the way it looks and feels, its general appearance. The positioning of the body of the performer in relation to the instrument is also important: in fact, the human body as shaped by a particular instrument is an integral part of the full visual impression caused by such instrument. It is interesting to note that, in a 2009 paper about the creation of SLOrk [12], the desire to design meta-instruments with a "particular identity and presence" was in fact explicitly expressed.

4.2. Movement

Movement, for the purposes of this paper, is the realization in time of the potential seen in presence. Movement is the theater of human and instrument in motion, whereas presence is a snapshot of that motion.

[2]Denis Smalley's "spectromorphology" [10] and Rolfe Inge Godøy's "gestural-sonorous objects" [3] are examples of previous research expanding Schaefferian concepts. Of particular interest in the context of this paper are Godøy's "embodied extensions" of the idea of sonorous object. Recognizing that Schaeffer himself made use of gestural concepts and metaphors in analyzing and qualifying sounds, Godøy has advanced the notion of "gestural-sonorous objects," meaning "an extension of Schaeffer's thoughts on exploring sonorous objects to also include the exploration of gestures associated with the various sonorous objects." (Godøy, p. 150)

- Gestures and body movements that are required to play the instrument;
- Movements that are by-products of required ones;
- Movements that are traditionally seen as idiomatic or expressive, even if not strictly required to produce the desired sound.

These "sound-producing gestures" [3] and other non-sound-producing but closely related movements, taken as a coherent whole, work together to consolidate our perception of what that instrument is. Virtuosism, in part, comes from our estimation of the scope and difficulty of the performer's actions, even if we do not play the instrument. There is a shared sense of what is easy and what is hard to do with it. Finally, a fundamental paradigm of acoustic instruments is: when movement stops, sound stops. In other words, action equals sound, rest equals silence.

Laptop performances have clearly taken to the extreme the disconnect between action and sound.

4.3. History

Finally, the history and the culture surrounding a musical instrument are crucial components of our understanding of what that instrument is.

- The historical repertoire that follows the instrument and player wherever they go;
- The conventions of playing;
- The social contexts in which the instrument is used;
- Cultural icons and associations attached to the instrument and its community of users.

It is in part because of the history of the violin, and our previous exposure to it, that we are able to file under "violin" the bowed note and the pizzicato. A newly invented instrument has no history of its own, but often it ends up associated with other instruments by similarity of sound, gestures, and appearance. Quickly, then, other histories get attached to the new instrument and may even shape the way this new instrument is used and developed (one may think, for example, of the theremin and its early connection with violin music).

4.3.1. Making mistakes

Finally, in the intersection of sound, movement, and history there is the possibility of performative mistakes. A simple definition of mistake from the perspective of movement could be something like "the failure to realize a gesture as initially intended." This narrower view, however, quickly becomes insufficient without a history behind it to give it meaning. The notion of making a mistake while playing,

from both the player and the listener's perspectives, requires a clear musical context. In some cases this context is provided by a common musical language. In experimental music, when a clear common language is absent, this context has to be supplied in real time by composers and performers. An electronic instrument can certainly be designed to prevent most mistakes from the part of the player; but this may end up being a less interesting instrument. The possibility of musical mistakes, however they may be defined, is, I think, one of the essential features of a musical instrument.

4.4. Composing contexts

In fact, one unique aspect of live laptop performances may be precisely the need to be constantly defining contexts in real time for the listener, in all these dimensions: sound, presence, movement, and even history. An interesting laptop-mediated instrument may be one that successfully conveys its own rules and contexts, creating provisional but credible expectations, and also interesting violations of these expectations.

I do not claim that the categories discussed above are sufficient, or always adequate, to account for all the new possibilities of musical performance available today. But it is a good starting point for a laptop orchestra composer to ask the following question: what combinations of software and hardware, in the context of a laptop-mediated ensemble, would satisfy those criteria in some way?

5. EXAMPLES

As examples, in this section I will briefly discuss two pieces played by SLOrk in the Spring of 2010.

5.1. Intellectual Impropery 0.6

Often, a laptop orchestra appears to the audience as a group of motionless performers completely absorbed by the computer screen. As a matter of fact, my own composition Intellectual Improperty 0.6 is one of those pieces with motionless performers [6].

In Intellectual Improperty 0.6 I did not set out to deal with the problems of presence or movement. Instead, I focused on the creation of a meaningful playing environment in which the players would have a clear sense of individual responsibility, and a clear sense of connection with the ensemble. An intrinsic part of the work in instrument design and composition was to create room for performative freedom, leaving open the possibility for performative mistakes.

The player interface is built with MaxMSP. The sound generation is based on CataRT, a concatenative synthesis engine by Diemo Schwarz [9]. The custom graphic user interface and playing mechanism became what I call Catork (see Figure 1), a CataRT "skin" optimized for laptop orchestras [7]. Players learn a series of keyboard shortcuts

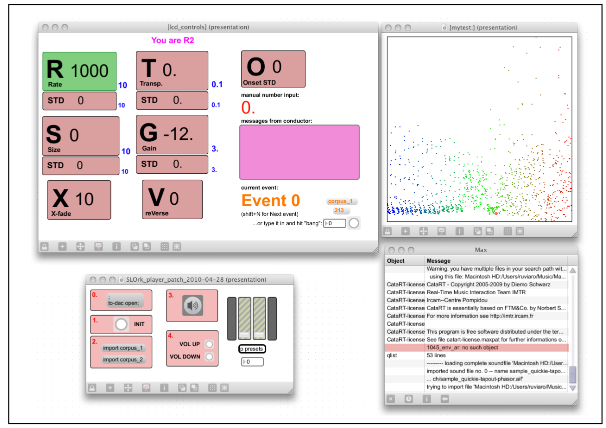

Figure 1. Catork player interface.

to control the various granulation parameters. The interface also implements an instant messaging system allowing the conductor to send on-screen text instructions to all players during the performance. The conductor also cues in various sub-sections of the orchestra at different moments in the composition.

This piece has strong and weak points. For example, the controlled sound world successfully creates the possibility for expectation, surprise, and mistakes; and the "social networking" aspect between conductor and players via instant messages creates an interesting sense of engagement among ensemble members. On the other hand, the issue of the static motionless performers is left unresolved. One of the most troubling questions is, perhaps, "Are we talking about potentially interesting acousmatic music that unfortunately has a group of people on stage to spoil its acousmatic-ness?" Is it not one of the challenges of a laptop ensemble to propose at least a tentative solution to this question?

5.2. Headbang Orchestra

The piece Cop de Cap was a class project made by a group of Stanford students in the Spring of 2010 [2]. (Please watch the video available on YouTube to better understand the argument to follow). This intriguing experiment touches on several of the questions raised above. The body motion of the performers is captured by a thin invisible wire (an elastic band) attached to their heads and hands. There is a person occupying the role of a traditional conductor, while the rest of the orchestra realizes rhythmically coreographed movements that emulate idiomatic gestures from the chosen musical style (heavy metal). There is, clearly, a peculiar *presence*, a unique posture the performers have to adopt as they stand up with the thin, invisible wire attached to their heads. One of the most curious aspects of this piece, however, is located in the intersection of *movement* and *history*. The stylized idiomatic gestures become the actual movements required to produce sound. The coordinated motion of all

players contribute to form the entire sound of the band. Each performer has a specific role (hi-hat, guitar, snare drum, etc.); there is a clear sense of mistake when it happens; the range of movements is clearly defined for performers, and the audience understands it pretty quickly. The piece borrows historical and cultural background associated with the genre. Just as the theremin borrowed repertoire, history, and audience from the violin, this specific instrument attempts to borrow from Heavy Metal more than just its sounds; it is actually converting culturally codified gestures into the very action and coreography of playing.

6. FINAL DIGRESSION

By using external controllers and interfaces for musical expression, a laptop performer engages on gestural activity that allows a reapproximation with the dimension of movement. The performer is no longer motionless. Interestingly, however, the more we focus our attention on gestural activity that is only indirectly connected to the body of the laptop, the less important becomes the visual of the laptop itself on stage. The actual laptop begins to look as an accessory, a mere processor of instructions; it appears less, or not at all, as the instrument.

In addition, small pocket devices will soon have enough processing power to do anything a laptop can do today. At that point, the on-stage presence of an object such as a laptop may become completely unnecessary. The only hardware visible to the audience will be those the performer chooses to make visible, hopefully for an artistic reason. Everything else that does not strictly need to be seen on stage will naturally disappear from the scene (either because its size will be small enough, or because it can be placed offstage and be wirelessly controlled). With increasing portability and miniaturization, visibility of any hardware will more and more become a creative option rather than a fact of life. The theater of a performance, then, may reappear in the actual human body. Musical gestures may still rely on the use of specific interfaces, but at times they may also be completely unmediated by any visible device. The expression "laptop performance" may become as dated as the expression "tape music" today.

Will some electronic musicians, then, have to become proficient dancers? We do not know whether non-tactile music-making can become as engaging and important to humans as tactile instruments have been, but we may wonder: when the last laptop is removed from the stage, will musicians rely more on their bodies alone to control musical actions, with zero or minimum interaction with visible, physical devices?

I would like to close by quoting Bob Ostertag. In a 2002 article he wrote that *th[is] problem has been reformulated again and again in various ways yet never solved. For the entire problem is just one window into the tension (...) between the human body and the machine. (...) It cannot be solved in the sense of a solution that can make a problem disappear. It can only be experienced in various ways. (...) [A]rtists who use machines must do so critically; not celebrating technology but questioning and probing it, examining its problematic nature, illuminating or clarifying tensions between technology and the body, and thus offering the kinds of insights only art can provide concerning the nature of life*. [5]

7. REFERENCES

[1] M. Chion, *Guide des Objets Sonores*. Paris: Buchet/Castel, 1983.

[2] N. U. S. A. Forkish, C., "Cop de Cap," 2010, last accessed February 2012. [Online]. Available: http://www.youtube.com/watch?v=0ifxD-CeXII

[3] R. I. Godøy, "Gestural-sonorous objects: embodied extensions of schaeffer's conceptual apparatus," *Organised Sound*, vol. 11:2, pp. 149–157, 2006.

[4] R. Henke, "Live performance in the age of supercomputing," 2007, last accessed February 2012. [Online]. Available: http://www.monolake.de/interviews/supercomputing.html

[5] B. Ostertag, "Human bodies, computer music," *Leonardo Music Journal*, vol. 12, pp. 11–14, 2002.

[6] B. Ruviaro, "Intellectual Improperty 0.6," 2010, last accessed February 2012. [Online]. Available: http://vimeo.com/12372025

[7] ——, "Intellectual Improperty: Musical borrowing as manifest in acoustic and electroacoustic compositions," DMA dissertation, Stanford University, June 2010.

[8] P. Schaeffer, *Traité des Objets Musicaux*. Paris: Éditions du Seuil, 1966.

[9] D. Schwarz, "Concatenative sound synthesis: the early years," *Journal of New Music Research*, vol. 35:1, pp. 3–22, 2006.

[10] D. Smalley, "Spectromorphology: explaining soundshapes," *Organised Sound*, vol. 2:2, pp. 107–126, 1997.

[11] T. D. C. P. W. G. Smallwood, S., "Composing for laptop orchestra," *Computer Music Journal*, vol. 32:1, pp. 9–25, 2008.

[12] B. N. O. J. H. R. Wang, G., "Stanford Laptop Orchestra (SLOrk)," in *Proceedings of the International Computer Music Conference*, Montreal, Canada, 2009.

LELA: LAPTOP ENSEMBLE LIBRARY & ARCHIVE

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ABSTRACT

Code and data management, distribution, and archiving are challenges for all electronic media, including music. While a number of electronic archives for conventional scores exist, there are none for electronic ensembles. The Laptop Ensemble Library & Archive (LELA) is intended to serve as an active repository for digital artifacts relating to the compositional and performance practice of laptop ensembles, including concert programs, photographs, audio or video recordings of performances, and other records pertaining to live performances by LEOs.

1. INTRODUCTION

Code and data management, distribution, and archiving is a challenge for all electronic media, including music. While a number of electronic archives have been developed for conventional scores, there are none dedicated exclusively for electronic or computer music, and especially for laptop/mobile ensembles and orchestras (LEOs). Moreover, there is a critical need for a central repository of information about laptop ensembles, as documentation of both individual ensemble activities and the rapidly developing LEO culture, and as a resource for the authoritative distribution of music/software needed for the performance of music for LEOs.

The Laptop Ensemble Library & Archive (LELA) is an archive and distribution application for LEO compositions. In addition, LELA will serve as an active repository for digital artifacts relating to the compositional and performance practice of laptop ensembles. These artifacts may include concert programs, photographs, audio or video recordings of performances, and other records pertaining to live performances by LEOs.

2. DIGITAL ARCHIVES

Generally speaking, there are many challenges in creating archives of digital assets and materials, including but not limited to longevity of the assets, sustainability of archived software, metadata, and interoperability. For example, five to seven years is considered the limit on how long most electronic data or software can be archived and reliably retrieved. But librarians and archivists look at preservation of materials on a scale of hundreds of years, something for which we have no precedent in the computational world. The result has been that many archivists focus on timeframes of 20-30 years for electronic records, relying on having longer term solutions being developed in the interim[6].

Another challenge in digital archives is the issue of sustainability, or the ability to recreate the computational activity that has been stored. For example, a digital archive for laptop ensemble music would naturally include software code designed for a particular piece of music that uses a specific computational framework (i.e. a Max patch that has been developed and tested on Max version 5). But what if, in 10 years, someone wants to perform that composition, and the current version of Max (if it is still available as a software product) is Max 9, and the code base for this version of the framework is incompatible with the version 5 patch? What would be the value of an archive of material that could not be properly rendered in the future?

These challenges are generally beyond the scope of this project. But they demand that we at least explore options as to how to address them, should we decide that it is feasible to do so. Our strategy for the initial version of LELA has been to create an archive that incorporates standardized metadata and utilizes a robust and extensible infrastructure developed principally for digital humanities archives. This approach should ensure that our metadata and digital materials can be viewed and accessed by a larger community, and that the underlying software will continue to be available, affordable, and up to date. We readily accept that we must address the issues of data longevity and software sustainability in future editions of the archive.

2.1. Dublin Core

The Dublin Core Metadata Initiative[9] is a broad international effort to establish a standard set of metadata elements which could be used for all types of digital assets. Early efforts popularized the notion of 15 "core metadata" elements (such as creator, date, title, subject, source), and it

has since become part of the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), and ratified as both an ANSI and ISO standard.

We chose to use the Dublin Core as the basis of our metadata schema to enable broad interoperability between LELA and other archives and search engines, as well as to provide a core set of informational structures that would help us understand what we needed to archive, and how we needed to describe the digital objects. Decisions about our software infrastructure also relied upon our decision to use this standard.

3. LELA STRUCTURE & ORGANIZATION

LELA is implemented on the Omeka content management and web publishing platform[7]. The Omeka system stores and publishes digital artifacts or *items* that are then grouped into *collections*. As the number of items in a collection reaches a critical mass, a digital *exhibit* from a particular collection is developed to provide a curated approach to the archive's important data.

3.1. Items

Each LELA item consists of a digital object that contains the unique artifact, along with the appropriate metadata to describe important properties of the artifact. In some cases, the LELA item only holds metadata about a digital artifact, but also includes a qualified URL that points the user to some other online location where the actual artifact may reside.

The digital artifact may be in the form of text, references to remote resources or attached files. The metadata provides information that enables users to search for, identify and retrieve said artifacts. While it is our intention to collect all digital artifacts wherever possible, some objects (i.e. YouTube videos) can only reside in a proprietary format or archive where we can have relatively strong assurances that the artifacts will be preserved.

3.2. Collections

Like items are organized by *collections*. Initial LELA collections include Ensembles, Compositions, and the SLEO Video Archive. The Ensembles collection contains information about particular laptop orchestras or other ensembles, including location and leadership. The Compositions collection contains composition bundles —zip files (or other archives) providing the necessary information for an ensemble to perform a piece. The SLEO Video Archive provides a repository for video recordings of ensemble performances, and is a product of the 1st Symposium on Laptop Ensembles and Orchestras (SLEO 2012), which is to be held April 15-17, 2012, at Louisiana State University, in Baton Rouge, Louisiana[1].

3.3. Exhibits

Exhibits are curated presentations of items from various collections in the archive. Our first exhibit will be a presentation of the SLEO Video Archive described above in section 3.2. When this exhibit is complete, it will be the model for the kind of cultural exposition we hope to generate with all of the elements stored in the archive. Users can also browse Compositions stored in the archive, and we have plans to create a curated narrative of the beginnings of the laptop and mobile ensemble culture that has so rapidly emerged from the late 2000's.

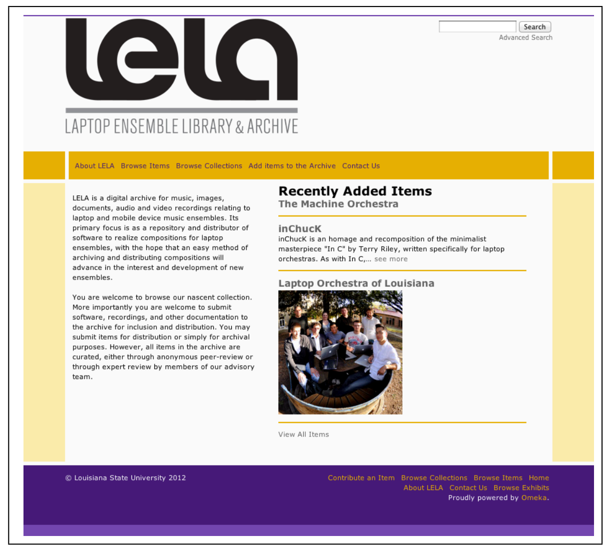

Figure 1. LELA front page

3.4. Architecture

The architecture of LELA is largely determined by the underlying Omeka platform. Omeka is a LAMP (Linux, Apache, MySql, Php) server application originally developed for digital history scholarship by the Roy Rosenzweig Center for History and New Media at George Mason University[7]. Omeka's flexible plugin architecture and strong relational data framework make it ideal as a prototype platform for LELA. The platform is free and open-source, distributed under the GNU General Public License (GPL).

3.5. LELA Contributions

LELA currently accepts contributions of composition software bundles, information about laptop and mobile ensembles, and video recordings of laptop ensemble music performances.

3.5.1. *Composition Bundles*

Composition bundles are archives (zip or tar files) that contain the necessary code and instructions to perform a piece. Bundled directories can be in any hierarchy, as appropriate to the composition. Those bundles that are GRENDL compatible must be in the correct directory structure in order to operate automatically within the GRENDL framework.

Data Element	**LELA Description** (if different)	**Metadata Set**
Title		DCMI
Date	Year Composed	DCMI
Version	Version or revision	LELA
Creator	Composer	DCMI
Publisher		DCMI
Rights	Rights & Licensing	DCMI
Source		DCMI
Description		DCMI
Program Notes		LELA
Req. Software		LELA
Req. Hardware		LELA
Network Reqs.		LELA
GRENDL Version		LELA
URL	Source URL (if online elsewhere)	LELA

Table 1. Metadata Elements for LEO Composition Bundles

Contributor-entered metadata for composition bundles comprises seven of the fifteen Dublin Core Elements, as well as seven elements defined specifically for LELA compositions (Table 1). In some cases, alternate element labels have been adopted for greater clarity or applicability to the music domain. Other Dublin Core elements, such as *Contributor* and *Identifier*, are inferred using Omeka.

3.5.2. *Ensemble Information*

As the LEO community grows, one important use of LELA can be as an informal registry of groups. LELA users will have the ability to locate and contact peer groups, as well as viewing their original compositions and recordings of their performances. Contributions to the Ensembles collection include ensemble names, directors, affiliations, locations, year establish, a text description of the ensemble, and an URL for the group's website.

3.5.3. *Video Recordings*

LELA is also home to the SLEO Video Archive, a peer-reviewed collection of videos submitted to the SLEO 2012 conference at Louisiana State University[1]. When complete, the archive will represent a baseline documentation of exemplar music compositions and current performance practice for laptop and mobile ensembles. The archive is not accepting additional videos at this time, but will likely become part of a larger collection of video documentation, including but not limited to performances and ethnographies.

4. USING LELA

4.1. Navigation

There are three primary navigation schemes implemented in LELA: exhibits, content browsing, and searching. Content browsing is the least scalable, and is used primarily by site administrators for management of content.

While collections are primarily intended to aggregate like content, exhibits offer the ability to collect and display possibly unrelated items that are of interest when viewed together. For example, in addition to highlighting the video archive, the SLEO exhibit can include connections to the ensembles represented at the Symposium, or even the compositions played during the event.

As the repository grows, searching will become increasingly important to navigating the site. Search terms can include any of the metadata fields, so users will be able to find compositions based on titles, composers, or the types of middleware required to play a piece.

4.2. Adding Content

The public area of LELA (http://lela.cct.lsu.edu) allows anyone to access content that is marked public. Anonymous users may submit content using the Contributions plugin (Figure 2) . Submissions are mediated by LELA administrators, and will not be visible on the public site until approved. Authorized users may also use Omeka's administration interface to add items, collections, and exhibits directly, manually entering the necessary metadata.

4.3. LELA and GRENDL

GRENDL[4] is a software system for distributing composition bundles, as well as configuring, launching and shutting down middleware, for LEO performances. Originally developed in 2010, GRENDL has been reengineered to retrieve compositions via HTTP, enabling close integration with LELA. When this integration is complete, ensembles using GRENDL will be able to download and begin playing a piece (assuming that performers' machines meet the composition's requirements) by selecting the LELA archive and the composition in the GRENDL Conductor interface.

Interoperability with GRENDL was an important decision criteria for LELA. Any composition bundle can be used with GRENDL if it includes the necessary scripts. The most straightforward implementation involves including *scripts* and *code* folders. By default, GRENDL looks for scripts

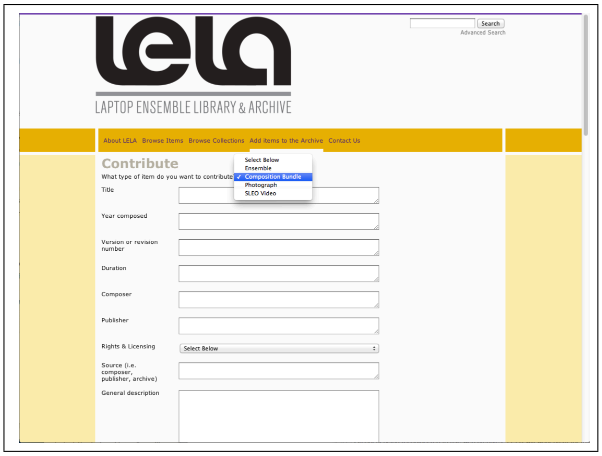

Figure 2. The LELA Contributions page enables users to submit items directly to the system. Contributions are mediated and not visible to public users until approved

named *transfer.sh*, *start.sh*, and *quit.sh* in the scripts folder of a composition.

5. FUTURE STRATEGIES AND DIRECTIONS

We recognize that while LELA may be an important effort in preserving and distributing LEO music and digital artifacts, it is only a first step, and one that needs additional development. These areas of future development include long-term data storage, improved metadata schema, flexible data access, and software framework preservation.

Although we are still developing plans for long-term data storage strategies, our intention is to employ a high-performance computing (HPC) storage solution known as the "integrated Rule-Oriented Data System" (iRODS[8]) for the physical backup and archive of LELA materials. iRODS uses a distributed data model that deploys redundant data clusters across a wide-area network, with multiple levels of accessibility (near-term, medium-term and long-term). iRODS is a standard archive solution in the HPC community and is well supported by an active computational science community. We expect that iRODS integration will be deployed in our next version of LELA.

Metadata is key to any successful archive. In addition to the DCMI and LELA metadata elements defined for contents, extensions such as Dublin Core Application Profiles will be important for structuring and documenting community efforts to define and manage the LELA archive. Application profiles facilitate sharing and linking of data within and between communities, helping integrate repositories and other data management systems with each other. Interoperability can increase the impact of a repository while limiting the scope of the content that must be stored directly.

Web services are planned that allow GRENDL (and other programs) to browse/search the LELA catalog and automatically add compositions to a program. This functionality is essential to effective integration with GRENDL, and is part of the motivation behind both projects.

One of the biggest challenges for LELA is ensuring that executable composition elements will remain viable over time. Myriad technical (e.g. changing hardware requirements) and licensing issues prevent direct storage of required software frameworks (such as Max, Chuck, SuperCollider) from being a complete solution to this problem. Current best practice for electronic archives is to refresh—and if necessary, convert—digital artifacts periodically, an approach that will become increasingly expensive and time-consuming as the archive grows.

6. CONCLUSION

LELA provides a first step toward recording and preserving electronic and computer music for laptop/mobile ensembles and orchestras (LEOs), as well as information on the ensembles themselves. As with any community resource, the success of LELA will ultimately be determined by participation of LEO musicians and composers. It is our hope that LELA will prove useful to both experienced and novice laptop/mobile ensembles, and that its motivation and implementation could be leveraged to support archiving of digital assets relating to other aspects of computer and electronic music disciplines.

7. REFERENCES

[1] "1st Symposium on Laptop Ensembles and Orchestras," 2012. [Online]. Available: http://sleo2012.cct.lsu.edu/

[2] S. Beck, C. Branton, and S. Maddineni, "Tangible Performance Management of Grid-based Laptop Orchestras," in *Proceedings of the International Conference on New Interfaces for Musical Expression*. NIME, 2011, pp. 207–210.

[3] C. Dollar, *Authentic electronic records: strategies for long-term access*. Cohasset Associates, 2000.

[4] A. Morton, "Digital Tools: Zotero and Omeka," *Journal of American History*, vol. 98, no. 3, pp. 952–953, 2011. [Online]. Available: http://jah.oxfordjournals.org/content/98/3/952.short

[5] A. Rajasekar, R. Moore, C. Hou, C. Lee, R. Marciano, A. de Torcy, M. Wan, W. Schroeder, S. Chen, L. Gilbert *et al.*, "iRODS primer: integrated rule-oriented data system," *Synthesis Lectures on Information Concepts, Retrieval, and Services*, vol. 2, no. 1, pp. 1–143, 2010.

[6] S. Weibel, J. Kunze, C. Lagoze, and M. Wolf, "Dublin core metadata for resource discovery," *Internet Engineering Task Force RFC*, vol. 2413, 1998.

MEDIA REPRESENTATIONS OF THE LAPTOP AS MUSICAL INSTRUMENT

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EXTENDED ABSTRACT

Judging by the language used to describe the laptop's role on the performance stage over the last ten years, many popular media outlets have come to accept the laptop as a musical instrument. While laptop ensembles and orchestras (LEOs) have played a significant role in this evolving public awareness, one cannot deny the impact of more danceable genres, often referred to as electronica. For certain readers, the term "laptop music" has quickly become a genre of music with its own expectations. As LEO practitioners, it behooves us to pay close attention to the way media outlets reinforce these expectations to the public so that we can be more effective advocates for what makes our art distinct. This presentation will identify key articles and stories in the evolving media presentation of laptop performance in electronic music, survey the way media factors into common stereotypes about laptop performance and raise issues that we as practitioners must address when faced with questions about and from the media.

Based on a survey of United States media items from the last 20 years, there appears to have been a turning point in late 2001 and early 2002 after which the language used to describe the laptop in musical performance starts to become more familiar. It was during this time that three items appeared in large publications with substantial audiences. The first was a short piece that appeared in The New York Times Magazine on 9 Dec 2001 entitled "Laptop Composing." The article attempts to take stock of the "virtual recording studio" trend, but also includes a references to Matmos providing "laptop accompaniment" for Björk's Vespertine tour and Herbie Hancock adding "an iBook to the instruments in his touring ensemble" [1]. The second item during this time period was a feature for the 26 Feb 2002 edition of NPR's All Things Considered. In the piece, Will Hermes laments that often "there wasn't a lot to see" during a laptop performance, but also astutely explains that "[l]aptop music is more an approach than a genre" [2]. The third and largest item in the group was a feature story in the May 2002 issue of Wired magazine. The piece ran with the ominous subtitle "First software turned the laptop into a musical instrument. Now who's in control: the machine or the musician?" [3]. Despite this, the article provides a useful survey of artists from the electronica scene who were using laptop computers in performance, including their rituals and habits.

After this turning point, some of the novelty wears off and the the media uses language that mirrors descriptions of more established musical instruments with increased frequency, including the use of terms like "laptop gigs" and "laptop accompaniment". In 2003, The New York Times featured an article about the Share laptop "jam sessions" that attracted dozens of musicians to an East Village bar (a gathering that was also profiled in the 2002 Wired article). The article featured the expert input of Jon Appleton and one hears echos of an earlier theme in his quote that "the performers understand what they're doing, but the audience doesn't" [4]. The quote embodies the most common stereotype in laptop performance: that the audience struggles to determine a causal relationship between the physical actions on stage that the sound emanating from the speakers. This stereotype is repeated consistently in the media and even the highly regarded PLOrk is not immune from its effects. During their 2008 trip to perform at Northwestern University, the Chicago Tribune offered hope that the laptop might reintroduce the "cherished element of spontaneity that had been left behind" [5] in concerts of academic electronic music. The student paper was less understanding (and less kind), summarizing the performance by saying that members of the ensemble "might as well have been a bunch of students sitting next to speakers doing homework" [6]. The stereotype has become so pervasive that some musicians in the electronica scene feel the need to assert in interviews that they "are not at all a laptop act" [7].

It is unlikely that anyone is completely happy with the way laptop performers are depicted in the popular media, where Girl Talk [8] appears to get more attention than all of the *LOrks combined. While there are key distinctions between the work of LEO practitioners and their fellow laptop performers in electronica, the two strands are easily conflated by the media and public. Because the novelty of laptops on stage has worn off, tougher questions have started to come to the fore and LEO practitioners must be prepared to engage them. Why make music in a LEO [9]? What are the similarities and differences between LEOs and other laptop performers? Is laptop music an approach or a genre? How can we overcome the disconnect between

actions and the sounds they cause? Is the answer better education for our audience? Is the answer an expanded definition of the instrument [10]? And if the casual observer believes Girl Talk is the "patron saint of laptop music" [11], how can we ensure that the LEO community's heros of the faith are canonized too?

1. REFERENCES

[1] Sanneh, K. 2001. "THE YEAR IN IDEAS: A TO Z.; Laptop Composing." *The New York Times Magazine*, 9 December 2001. Accessed online http://www.nytimes.com/2001/12/09/magazine/the-year-in-ideas-a-to-z-laptop-composing.html, 16 January 2009.

[2] Hermes, W. 2002. "Profile: Popularity of Music Made with Laptop Computers." Transcript, *All Things Considered*, 26 February 2002. ProQuest (190086552).

[3] Davis, E. 2002. "Songs in the Key of F12." *Wired*, May 2002.

[4] Jainchill, J. 2003. "Clash, Then Synthesis: Joys of a Laptop Jam." *The New York Times*, 10 July 2003. Accessed online http://www.nytimes.com/2003/07/10/technology/clash-then-synthesis-joys-of-a-laptop-jam.html, 16 January 2009.

[5] Cameron, M. 2008. "Ensembles strike chords of modernity." *Chicago Tribune*, 8 April 2008. Accessed 16 January 2009. http://archives.chicagotribune.com/2008/apr/08/entertainment/chi-ovn_0408bangapr08.

[6] Ruth, L. 2008. "An orchestra, clad in orange socks, uses MacBooks as their instruments." *North by Northwestern*, 6 April 2008. Accessed 16 January 2009. http://www.northbynorthwestern.com/2008/04/8575/an-orchestra-clad-in-orange-socks-uses-macbooks-as-their-instruments/.

[7] Colman, T. 2007. "Booka Shade." *The Sydney Morning Herald*, 5 April 2007. Accessed 16 January 2009. http://www.smh.com.au/news/gig-reviews/booka-shade/2007/04/04/1175366301812.html.

[8] Illegal Art. 2011. "Girl Talk." Accessed 4 November 2011. http://illegal-art.net/girltalk/.

[9] Trueman, D. 2007. "Why a Laptop Orchestra?" *Organised Sound* 12(2):171–179.

[10] Ruviaro, B. 2010. "From Schaeffer to *LOrks: an expanded definition of musical instrument in the context of laptop orchestras." Presented at the 2010 SEAMUS National Conference, Miami, FL.

[11] Martell, M. 2009. "The Top 20 albums of 2008." *Seattle University Spectator Blog*. Accessed 1 November 2011. http://blog.su-spectator.com/?p=1157.

EYES OFF THE SCREEN! TECHNIQUES FOR RESTORING VISUAL FREEDOM IN LEO PERFORMANCE

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ABSTRACT

Solutions to the problem of disrupted visual communication in laptop ensembles are explored. Essential channels of visual interpersonal communication are found both between performers and audience and among the performers themselves. Because the use of a laptop computer is inherently visually oriented, it easily leads to visual fixation, possibly at the expense of audience or ensemble engagement. After examining impediments to visual communication, strategies are presented relating to laptop ensemble or orchestra (LEO) instrument design with respect to the different types of information that the performer may need to receive or access or monitor: user input feedback, non-immediate or timed computational results, and networked information. Although the primary focus of this examination is geared toward the designer of software "instruments" for the LEO, other strategies are acknowledged that may assist in restoring visual freedom.

1. INTRODUCTION

In live laptop ensemble or orchestra (LEO) performance, there is enormous variety in technological, compositional, and organizational dynamics. In fact, this diversity is deservedly celebrated as one of the great assets of the medium. Amidst such variety the essential commonalities are few in number but establish the central features of the laptop ensemble. By definition, the ensemble consists of a group of (real) people. For this group, the laptop computer is the common tool, central hub of processing, irrespective of variations in user interface and/or supplemental processing. And in order for it to be considered "performance", there must be an audience to receive it.

The two vital channels of communication in such an ensemble are between players and audience, and between the performers themselves (including in many instances a conductor). And despite the sonic nature of the medium, the visual role in these channels of communication is prominent and is conveyed through gestures and movements, whether directly involved in sound production, directed at engaging other performers, or expressing an ancillary or emotional meaning [10]. The relationship between the performer and audience is performative in the sense that the audience derives meaning and appreciation from the visual spectacle of the performance, which accompanies or enhances the aural information. Communication between performers, essential to the concept of "ensemble", also has a prominent visual component. It can range from cues or confirmation of synchronized activity to expressions of communal music-making and shared experience such as smiles, head nods or eye contact. This performer-performer communication, visible to the audience, augments the visual spectacle and contributes to the audience-performer communication. In that sense the audience experience includes not only a regard for the individual performers but for their interaction as well.

2. OBSTACLES TO COMMUNICATION IN THE LEO

As the LEO has developed over the years, two recurring concerns have surfaced. The first is that the audience's sense of meaning and connection to the performance is compromised. The performance doesn't make gestural sense in the way that an audience may be accustomed to expecting. Unlike a violinist, whose instrument and performative gestures match the appearance of what is happening, a laptop performer often generates sounds with no matching physical gesture. For this and other reasons, the physical setup of a LEO is not predisposed to engage the audience visually.

The second is that the performers themselves are often disconnected to varying degrees from their fellow ensemble members, due to any of a number of factors:

instrumental or compositional complexity; the shifting demands of each new composition/instrument design; or the fact that the ensemble make up might consist of programmers, engineers, musicians, and other neophytes who have varying comfort levels with performance dynamics. Regardless of the cause, the general result is often that the each ensemble member is buried in the glow of their display, unaware of or disengaged from their fellow performers. This relative isolation not only further colors the audience's reception, but also visually undermines the concept of an ensemble, i.e. functioning together.

We see these two concerns as related to one another, and thus an examination of visual communication in the LEO is a relevant path to unraveling the dynamics of the ensemble and planning for new works.

2.1. The Loss of Audience Engagement

When communication with the performer is disrupted, the audience is susceptible to losing a sense of engagement and participation in the performance and being reduced to a group of passive fishbowl observers whose presence in the space feels disengaged. By extension, the players are unable to respond to or feed off the energy of the audience.

One obstacle to communication between performers and audience is the body language of the laptop performer. Typically it implies isolation and exclusion. This onstage alienation mirrors the relationship between people and their electronic devices that is witnessed daily in society at large. Upon seeing someone buried in his/her device, it is easy to get the message, "Don't bother me; I'm busy." Thus in addition to the audience's actual experience and reactions described above, audience members bring their own experiences and associations to their interpretation of a performance. Individual past experiences of the laptop computer as an impediment to interpersonal communication can influence their experience as audience members, and such associations present additional hurdles to achieving the kind of audience rapport that a traditional instrumentalist enjoys.

The physical nature of the human/laptop interaction also tends to conceal what the performer is actually doing. As observed by John Gibson, "For anyone witnessing a laptop performance, it can be hard to dismiss the nagging thought that the performers are merely checking their email. They sit motionless and stare at screens, oddly detached from the lively sounds they produce." [7]

Perhaps some patience is required of the audience. While the stage demeanor of a violinist is for the most part a learned skill, it may be that the laptop performer's cadre of skills is simply at an amoebic state of evolution. In discussing the inherent performative challenges of laptop performance and the audience's nagging suspicion that the performer is not engaged, Gibson continues, "In *Wind Farm*, a… performer can alleviate this feeling somewhat by exaggerating the physical production of his inertial scrolling trackpad gestures, by moving his arm more than is really necessary." [7]

The audience's alienation from the performers is not necessarily due to their suspicion that the performer is doing other computer activities. It can be attributed simply to the perceived loss of *performativity* stemming from "the lack of action and visual and tactile interaction between the performer and their instrument." [12] The minimal movement of the performer, often further obscured behind the display, and the disconnect between the performer's actions and the sounds produced, contribute significantly to this lack of "aura".

In addition to the audience's perception of a performer's activity, the audience's perception of the performer's *attention* is an important component of performativity. It may be that the interpretation of the performer's attention is much more significant than that of the performer's body in motion. After all, the empathetic impulse which makes the experience of a musical performance compelling requires that the observer imagine the performer's relationship to the creation of the music. Even the best instrumentalist, executing the most technically difficult passage, could ruin a performance with body language that communicates boredom. The point here is not the body language, but rather the observer's interpretation of the body language and its expression of the performer's relationship to the music she is creating. Consciously or unconsciously, the audience seeks empathy with the performer; therefore it is important that the performer imply something about her attention that is relevant to the rest of the experience of the performance.

The question of audience engagement or disengagement is therefore a more complex matter than it may appear, involving various aspects of performer behavior and audience perception.

2.2. Attempts to regain audience engagement

It seems that the question of audience engagement has been raised time and again in writing about the LEO. [2, 3, 4, 6, 7, 9, 12, 13] Much of this discussion has focused on the relative engagement or disengagement of the audience's visual attention. The problem of visually

engaging the audience is sometimes solved not by addressing the question of visual communication between audience and the laptop performers themselves but instead by introducing intermediary elements into the performance such as video, traditional instrumentalists or other devices. These solutions address the problem of audience engagement, often quite effectively, but tend to divert attention away from the laptop performer's attention rather than addressing or resolving the issue. Even with an instrumentalist on stage, the performative aspects of the laptop performers themselves are not resolved.

In addition to these may be included solutions that do involve visual communication by laptop performers: When performers use external controllers (phones, tablets, Wii controllers, MIDI controllers), or conductors and performers employ physical gestures, there is increased opportunity for the audience to experience the performance visually. The arrangement of the players on stage can help to engage the audience, making the performance more interesting to observe or allowing the audience to see the players' screens. [11, 7] The latter is similar to projecting performers' screens but localizes the display to the performers themselves. There is a tradeoff here, in that on the one hand, the audience may not be able to read the screen information at such a distance, without larger projection. Also, and more significant, the audience cannot see the performers' faces and frontal actions. But despite these barriers, this arrangement, on the other hand, might create a more intimate, "authentic", compelling for the audience since they are seeing over the performer's shoulder, viewing what the performer is actually seeing, rather than a projected "copy" of the display. This also draws the audience's gaze farther from the performer/ doer. Such novel arrangements can offer a solution to the engagement issues, but as with any orchestra or ensemble, they can also require more time for setup and coordination, especially if unfamiliar to performers and technicians, and even more so if the arrangements are changing during the program. [11]

Others suggest that the responsibility to convey meaning and appreciation lies not with the ensemble and its use of video, or external controllers, but rather with the audience and the way it approaches the performance. If the audience's construction of musical meaning or appreciation is lost when "the performer is seen as not interacting with [the audience], not engaging with them in a performative manner," then this line of reasoning charges that what is called for is "a shift in [the audience's] understanding of performance in the live computer-mediated digital audio environment from a visual focus to that of aural performativity." [12] However, it is difficult to distinguish this perspective from the view that the visual aspect of such performances is simply unimportant.

2.3. The Loss of Communication Between Players

In any ensemble performance decisions must be made with respect to inter-performer communication. These decisions range from total autonomy and separation to total engagement and interdependence. But is performance without communication between the players truly "ensemble" performance? Without some sort of communication between players, the idea of the "ensemble", and by extension any notion of ensemble coherence, is compromised.

There is also the issue of communication between performers, and in an orchestral model, between the conductor and players. Since the performers must look at their screens in order to perform, a natural tendency in instrument design is to channel some of the conductor's communication through the computer network rather than in the visual field. While networking is often used to great effect in resolving these competing visual objects of the conductor and the computer's material, the performative and hierarchical activity normally carried out visibly by the conductor is as a result concealed from the audience.

It is not necessarily a bad thing that networking can supplant some of the traditional communicative tasks of the conductor. Perhaps the traditional role of the conductor is overrated precisely because of her performative prominence. The widespread use of video as a visual focus can serve partly as a surrogate for visual focus. Perhaps the "conductor" is merely a coordinator, a supervisor, an organizer. Even without a surrogate central focus, if the conductor is not delivering functional gestures meant to shape the dynamics, tempo or other musical expression, then it may be best in some cases to step aside rather than to occupy the central place on the stage, a position that also reinforces the traditional communicative relationships among performers and to the audience.

3. THE SOURCE OF THE PROBLEM: VISUAL DEPENDENCE INHERENT TO THE LAPTOP INSTRUMENT

A great strength of the laptop as a musical instrument is the integration of the keyboard with the other types of input (keys, trackpad, external controllers) and output (video, sound), and the fact that the input and output are in a single

box whose interface with the performer is infinitely malleable. All this input and output affords the laptop computer a tremendous capability for visual feedback. This is both a strength and a weakness. Inherent in the laptop performer's relationship with the instrument computer is an intense visual component. It is therefore natural that the eyes should fall on the screen in laptop performance. However, that intensity can manifest itself as a dependence.

In order to begin to offer solutions, it is necessary first to ask why and to what extent is the visual component of the instrument important? What are the vital roles of the screen, and how malleable are they in allowing for increased visual freedom for the performer?

Discussing design issues for various sensor systems, Benford advocates taking into consideration five questions formulated by Bellotti et al. (2002) that are naturally, implicitly asked by users of sensing-based interaction systems:

(1) How do I address one (or more) of many possible devices?
(2) How do I know the system is ready and attending to my actions?
(3) How do I effect a meaningful action, control its extent, and possibly specify a target or targets for my action?
(4) How do I know the system is doing (has done) the right thing?
(5) How do I avoid mistakes? [2, 1]

These questions are posed to the designers but are phrased so as to position the designer as end user as well whose experience requires these questions to be addressed.

With music or sound-based art some of these concerns can be met through aural means, for example, effecting a meaningful action such as sweeping through a slider range, but to the extent that these questions involve visual display, they apply to the design of a LEO interface program, but it seems clear from these questions that the laptop screen has important roles to play.

As we narrow our focus from Bellotti's broader design base toward interface design specifically for the LEO, we find that visual information intended for the screen may be broken down into three basic forms according to its sources:

(1) user input feedback
(2) non-immediate or timed computational results
(3) communication via network

Most significantly, these streams of visual information differ from one another temporally. User input feedback is necessarily immediate. The results of computation can potentially happen at any time, and may be delayed through a piece's automatic timing or temporal sound processing. Communication via network may also be timed or happen asynchronously, but usually depends upon the behavior of other performers. Because each of these three categories of input is subject to independent timing (even in a strictly timed piece), they are best considered by the designer independently of one another. A decision about how to represent it may depend upon the source of the visual information intended for the screen.

3.1. User input feedback

In terms of user input feedback, one thing to look out for is the danger of fascination. It is possible to make an interface that is so fun to use—or on the other hand one that is so difficult to use—that the eyes are glued to it.

A second design recommendation to consider is to make important states or actions large. The purpose is both to make them visible to the performer's peripheral vision and to allow the performer to reorient his gaze quickly to the screen. The designer can use large regions or color fields and oversized, easy-to-see indicators to quickly orient the performer to the intended areas of the screen. Interface designers are often hesitant to use larger windows so that different screen resolutions can be accommodated, but using a single window, and allowing it to be viewed in full-screen mode will have the enhanced effect of producing a larger background. The color of the background can then be changed in real time and used to signal changes during the performance. Color panels can also be used and their background colors likewise dynamically changed in real-time.

The designer and composer can achieve temporal clarity by avoiding long periods of time where visual focus is caught up in a process or engaged in activity by making it clear when input is and isn't being received.

The designer can divorce gestural processes from visual activity when they have clear, perceptible sonic profiles, which will be discussed further below. In these cases, direct visual input verification can be smaller, less imposing, hidden, or excluded altogether, although for diagnostic or troubleshooting purposes it is preferable to have access to some visual input verification.

The cursor presents a problematic contradiction to this line of thinking. It is small, yet its position is often vital to the functioning of interactive, on-screen objects: switches,

sliders, dials, number boxes, etc. After looking up and back to the screen, the practice of cursor roaming is a common occurrence: the user moves the trackpad around in circles so that the tiny cursor, being in motion, will be found so that it may be used. We present two solutions to the problem of the cursor in the Max environment. First, mouse delta information, horizontal for example, can be scaled to the user's screen size and mapped to a large horizontal slider or another horizontal graphical object such as a filtergraph frequency, or with more effort can be manipulated in Jitter to produce similar, well visible results. This method represents a mapping of the cursor to new, more prominent visual features. It can be adapted to operate in a similar fashion for external controller ranges.

Second, the cursor model can be abandoned altogether, rather than mapped. This can be done by working directly with trackpad data. Max MSP offers the "hi" (human interface device) object, allowing the collection of motion data unlinked to any cursor position. Likewise, Michael & Max Egger's "fingerpinger" [5] external similarly provides access to several parameters of the track pad independent from the cursor. It is possible then to design an interface with no clickable onscreen objects, one that is entirely track pad-motion and keyboard controlled, and entirely cursor independent.

Depending upon whether the interface is devoid of objects susceptible to mouse control, the trackpad information can be used in addition to the cursor, allowing for toggling between the use of a cursor or not. In this scenario, the cursor is still available as a useful alternative, but trackpad data can be collected, and highlighted with further onscreen visual display.

It may be that for a skilled typist, the principle concern of the user in a laptop performance might boil down to the second of Bellotti's questions: "How do I know the system is ready and attending to my actions?"

But not all user input is typing. Other types of input require more feedback. Most laptops in use today include a built-in line/mic input, camera, sudden motion sensor (SMS) and potentially input from external controllers. The most important of Bellotti's questions in terms of visual feedback during performance are those of specifying a target for action and of confirming that the system is doing the right thing. Regarding the former, the user wishes to gain mastery of the input method. And with input types that generate audio directly, the user wants to have immediate verification that input was received and that things are working correctly (the latter question).

The instrument design can reduce the need for visual checking, for physically playing or getting feedback from the instrument. In PLOrk's performance of Curtis Bahn and Tomie Hahn's *In/Still*, for example, the performers' laptop screens displayed "very little information on them necessary for performing the piece," which reinforced the goal of having the performers watch the conductor/dancer "rather than watching their screens." [11] And instrument design can also reduce visual checking by avoiding the display of parameters that are aurally perceptible, such as filtergraphs or meters.

Gesture creation and recognition, i.e. the interpretation of complexes of input data as one input unit, requires an intermediary processing/calculation stage, and its feedback might take the form of a reduced data representation.

3.2. Non-immediate or timed computational results

In contrast to the program's acknowledgement of user input, a second important channel of information is the indication that a task that the computer has been given has been or is being accomplished. This criterion represents a diverse array of possibilities, from sound processing to number crunching to video processing, and so on. Again we are reminded of the diversity of LEOs and their aesthetics and practices. To complicate matters, the computation is often temporally integrated into the user's input in some way. Still, it would make practical sense to consider simultaneous visual response to be user input feedback, even if it represents computation or non-temporal sound processing. After all, at some level all visual feedback of user input is computational.

Algorithmic elements, automation, local temporal processes, as well as processes relating to previous user input fall within this category. Essentially any contribution made by the computer rather than by the user, and especially those contributions that differ temporally from user input, are at question here.

Because of the complexity of this boundless and unimaginably fertile realm, any recommendations about computational elements in instrument design must remain the most general in nature. Nevertheless, this examination leads to the formulation of a few simple principles of design applicable to our discussion:

- Don't say more than is necessary visually. The goal is the creation of sound.
- Form should follow function; address what needs to be communicated.

- Avoid fascinating visual displays if intended only for the performers.
- Avoid distracting cognitive information if possible.

Trueman addresses the issue of automation and audience engagement in terms of incorporating algorithmic components into the instrument design: "I am not arguing that we should eschew automation (or algorithmic/ generative systems) – after all, we should take advantage of the natural strengths of the laptop – but rather that we need to think carefully about how and when to automate, and how the players interface with this automation." [13]

3.3. Incoming network data design considerations

Whether communication from other computers arrives in the form of numerical data, notation, text or sound, it is still true that timing is everything. Textual communication and visual freedom are not mutually exclusive, but can coexist. The degree to which the visual field of the performer is occupied with textual communication can be determined by the designer and composer, but the first step in allowing that coexistence is to establish the terms under which communication is made.

A textual communication system that only intermittently draws the performer's attention will as a result allow for periods of time between transmissions of communication. This scenario is more analogous to telephonic text-messaging than to a telephonic conference call.

The crucial design step in bringing this state of affairs about is to allow for alerts that cannot fail to be recognized when new communication is received. If the presence of a new message is signaled not simply by a new command line but by the computer screen's background turning bright yellow, for instance, then even the peripheral vision of the performer can be engaged, and a moment of more careful visual focus can begin. Color coding systems can be developed on a composition-by-composition basis to differentiate between messages of varying importance or purpose, including signals about the status of the communication itself.

Non-textual data can incorporate similar alerts. For example, in a scenario where one performer receives a pitch class collection from another performer, the same system for alerting acknowledging the transmission can be used.

Regardless of whether networked information is text, graphical, notational, sound or other data, the system will allow greater visual freedom if the sender and receiver are both aware of the status of the information sent. The sequence of events would occur in the following order:

(1) sender transmits information to recipient
- alert appears on recipient's screen
- sender sees transmission as queued

(2) recipient acknowledges reception
- alert is removed from recipient's screen
- sender's queue is emptied

This exchange about the communication itself allows for the temporal separation of dialogue into discrete moments, freeing the performer's activity and attention in the intervening periods. It allows the performer to multitask and prioritize more effectively.

To be sure, with many textually networked compositions and ensembles this scenario will not be practicable, namely those in which the intensity of textual communication is a great source of the piece's or the ensemble's excitement, or where constant communication is the aesthetic and there is no need to look up from the screen.

There is a useful practice in chat design of indicating an act of communication in progress. This carries the meta-message "performer X is currently typing", and might be another useful alert for pieces using larger amounts of textual communication.

Color coding or graphical images can be used in conjunction with text to convey custom network information about a piece, for example signals to move to a new section or requests for certain timbres that can carry color-coding. Anything that allows for peripheral vision may be of help.

4. HAPTIC FEEDBACK AS AN ALTERNATIVE TO VISUAL DISPLAY

Far beyond the experimental stage, haptic devices are now ubiquitous and their characteristic buzzing vibration is increasingly integrated into the lexicon of familiar sensory cues with which performers are comfortable. Although not an internal feature of today's laptops, haptic motors are standard in a host of devices, including cell phones, tablets, Wii controllers, et cetera.

In laptop performance vibro-tactile feedback related to user input has been used in many circumstances to simulate the physical feedback mechanism natural to physical and musical interaction in the non-computer world (e.g. plucking a string is confirmed by physical vibration from the resonating body). This is done in order to restore intimacy between human player and instrument

and to simulate "meaningful physics" in the instrument. [4] Combined with resultant sounds, this linkage can create "a closed loop of… listening and sensing, playing and readjusting" and can thus "restore... vital sensory information." [9]

On a more basic level, haptic feedback can be used as a simple confirmation of user input, whether or not it correlates with or simulates the suggested physical action, e.g. short vibration in response to a slow sweeping track pad motion.

Vibro-tactile feedback can be used to great effect for cues and nudges between performers, offering an equally if not greater communicative intimacy than eye contact. Players can effectively remotely tap each other on the shoulder, prompting a direct performative action or indicating for the recipient to "look up!". Hayes and Michalakos' Networked Vibrotactile Improvisation System (NeVIS) offers a compelling example of this type of haptic cueing, with an explicit design goal "to enable as much freedom from the constraints of looking at laptop screens or focusing on interfaces other than the original acoustic instruments, which were employed both as sound sources and as controllers." [9]

These two improviser/ designers also make explicit the contributions that improved performer - performer communication can make to enhancing audience engagement and performativity, pointing out that the "private [haptic] method of interaction... arguably helped to give the audience the illusion of a more integrated and polished performance." [9]

5. THE THORNY ISSUE OF SONIC FEEDBACK AS AN ALTERNATIVE TO VISUAL DISPLAY

In the context of user input feedback, sonic cues can verify user actions, communicating either low-level information about the operation of the interface or higher-level (and perhaps more musically integrated) results of the user's actions. In a simplistic example of the former case, a beep, tone, click, etc., might indicate a button/toggle selected or the bounds of a continuous controller's range. Unless the sonic feedback is woven into the fabric of the piece as an audible, intentional feature, or unless the feedback is delivered privately (via in-ear monitor, etc.), this presents an obvious obstacle in its blurring the line between the content and feedback since the feedback and content occupy the same sensory dimension. The "solution" of making the sonic cues private via in-ear monitors or headphones presents its own disadvantages in performance, since it dislocates the performer's ears from sonic content of the piece and the live environment, further undermining the very efforts to unify that motivated the solution in the first place. [8]

The higher-level results of the user's actions, such as more complex signal processing or transformations triggered by the user, can be conveyed through sonic cues. These actions might be more organically integrated into the work when they are mapped to a synchronous and perceptible sonic result such as a continuous input sweep controlling the cutoff frequency of a lowpass filter. This type of feedback is proportionately less effective the more complex or obtuse the mapping of input to sonic result, or the more temporally separated the user actions are from the sonic result.

6. CONCLUSION

The efforts and principles outlined here to restore visual freedom for the laptop performer are not in any way intended to invalidate laptop performance that is oriented toward the screen and laptop operation. It is often perfectly appropriate for laptop performers to be buried in their screens, working away, "illuminated by the blue light emanating from the laptop's screen." [12] And perhaps part of the evolution of this medium may involve an acceptance of the laptop performer as a new kind of beast -- something more than a prop, and something less than a dancer. There have been and will be many excellent pieces written whose interfaces still consist of cursor-driven controls. But the fact remains that visual communication is a prominent feature of live performance and as such it is worthwhile to develop forward thinking design strategies that address such communication.

Of course, the success of visual communication among the performers and audience is not ensured by the design of the instrument alone. Contributions to this goal can be made by performance pedagogy, ensemble leadership and composition itself.

At this point further investigation is appropriate. Instrumental performance no doubt has lessons for us. What basic training in performance should be recommended for laptop performers that might help them think about the visual aspects of performance? What are other approaches to ensure communication and to help lift the eyes off the screen, if only for a moment?

7. REFERENCES

[1] Bellotti, V., et al. 2002. "Making Sense of Sensing Systems: Five Questions for Designers and Researchers." in *Proceedings of the 2002 SIGGHI Conference on Human Factors in Computing Systems*. New York: Associations of Computing Machinery, 415-422. [cited in Benford 2010, p.50]

[2] Benford, Steve. "Performing Musical Interaction: Lessons from the Study of Extended Theatrical Performances." in *Computer Music Journal* 34:4, Winter 2010: 49-61.

[3] Collins, Nick. "Generative Music and Laptop Performance." in *Contemporary Music Review*, Vol. 22, No. 4, 2003: 67-79.

[4] Cook, Perry. "Remutualizing the Musical Instrument: Co-Design of Synthesis Algorithms and Controllers." in *Journal of New Music Research*, Vol. 33, No. 3, 2004: 315–320.

[5] Egger, Michael and Max. Fingerpinger Max external. anyma research, 2009. http://www.anyma.ch/2009/research/multitouch-external-for-maxmsp/

[6] Freeman, Jason and Akito Van Troyer. "Collaborative Textual Improvisation in a Laptop Ensemble" in *Computer Music Journal*, 35:2, Summer 2011: 8-21.

[7] Gibson, John. "Wind Farm, a Composition for Laptop Orchestra." in *Proceedings of the Australasian Computer Music Conference*, 2010, Australasian Computer Music Association, June 2010: 85-87.

[8] Hayes, Lauren. "Vibrotactile Feedback-Assisted Performance" in Proceedings of the International Conference on New Interfaces for Musical Expression, 30 May - 1 June 2011, Oslo, Norway: 72-75.

[9] Hayes, Lauren and Christos Michalakos. "Imposing a Networked Vibrotactile Communication System for Improvisational Suggestion" in *Organised Sound* 17 (1): 36–44 & Cambridge University Press, 2012.

[10] Overholt, Dan, John Thompson, Lance Putnam, Bo Bell, Jim Kleban, Bob Sturm, JoAnn Kuchera-Morin. "A Multimodal System for Gesture Recognition in Interactive Music Performance." in *Computer Music Journal*, 33:4, Winter 2009: 69-82.

[11] Smallwood, Scott, Dan Trueman, Perry R. Cook, and Ge Wang. "Composing for Laptop Orchestra" in *Computer Music Journal*, 32:1, Spring 2008: 9-25.

[12] Stuart, Caleb. "The Object of Performance: Aural Performativity in Contemporary Laptop Music." in *Contemporary Music Review*, 22:4, 2003: 59-65.

[13] Trueman, Dan. "Why a Laptop Orchestra?" in *Organised Sound* 12(2), 2007: 171–179.

THE FLORIDA LEAGUE FOR INDETERMINATE PERFORMANCE: IDEALISM AND FAILURE IN IMPROVISATORY LAPTOP ENSEMBLE PERFORMANCE

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ABSTRACT

The four composer/performer members of the Florida League for Indeterminate Performance (FLIP) discuss the successes and failures of the ensemble from individual perspectives. Each section presents a subjective window into FLIP, informed by a member's own musical interests and ideals concerning laptop performance and improvisation. The windows presented can be encapsulated as follows: issues of spectacle and performance context, musical missteps and individual/group tension, thwarted orchestrational concerns respective to a free improvisation model, and a re-evaluation of the potential to not perform. In light of these individual perspectives, we begin to see FLIP as a discursive arena for music and music politics that surrounds a collaborative/confrontational performance practice.

1. INTRODUCTION

The Florida League for Indeterminate Performance (FLIP) has been active as a laptop ensemble since late 2010. Over the past year and a half, FLIP has performed several times as an improvisatory laptop ensemble in both academic and non-academic contexts. FLIP is comprised of four doctoral students in composition at the University of Florida in Gainesville, all of whom have significant experience with the tools and techniques of computer music. However, they have varying backgrounds concerning the discourse and practice of live improvisation (with or without the use of laptop). As four composers, the members of FLIP demonstrate exceedingly different compositional goals, processes, and thinking. These individualistic differences lie at the core of FLIP, in so far as the ensemble is an arena for musical and ideological juxtaposition, competition, compromise. With this in mind, the structure for this paper attempts to reflect the issues and ideals at stake within the ensemble directly by allowing each member to provide a particular understanding of FLIP, both its problems and its potential.

2. ADAM: ON SPECTACLE AND CONFRONTATION

The visual presentation of FLIP is minimal: four men behind their respective laptops, on a table facing the audience. This configuration is in no way unique within the wider context of electronic/electroacoustic performance practice, but has proven challenging to the perspectives of lay audiences who have seen us perform. With only four players, we cannot create the same sense of whimsical spectacle that laptop orchestras can evoke, and by sitting at tables facing the audience we have instead been described as confrontational.

As Kim Cascone writes, "audiences experience the laptop's use as a musical instrument as a violation of the codes of musical performance."[4] Audiences do not see a relationship between a laptop performer's actions and the resulting sounds. By facing the audience, whether on a stage or not, we have set up expectations of visual spectacle which are left unfulfilled.[10] In club settings, audiences are now accustomed to the non-virtuosic displays of DJs, because the DJs themselves are not the focus of the experience. FLIP has performed both in a bar and a concert hall, in each performance presented not as background for dancing, but as the sole focus of the experience. Thus, it seems even more inappropriate to use laptops in rock or classical settings than it is to use laptops in a club setting.

Our first two performances took place in a Gainesville bar, "The Laboratory," which has positioned itself as a haven for experimental musicians in the area. At The Laboratory, free improvisation and noise music reigns supreme, and as one would expect, the sounds produced by FLIP compliment the general tone of the venue. However, in great contrast to the other performers, the visual aspect of a FLIP performance is quite muted. The performers that frequent The Laboratory play a variety of instruments, from trombones to circuit-bent toys to microcassette recorders. For the majority of these players, visual spectacle and rebellious posturing take precedence over musical expression, such that the guitarist who thrashes around the most receives the most applause, regardless of musical skill or intent.

According to Nick Smith, "in order for music to be dissonant with contemporary consumer culture, it must risk its very identity as music."[9] It is ironic then, that these 'noise artists' who so earnestly attempt to be subversive through volume, timbre, and 'ineptitude' to borrow from Paul Hegarty still follow the same performance tropes as rock performance, moving with an oddly deliberate 'abandon.'[6] Without even trying, the relatively cold and stoic persona of FLIP accomplishes the noise-musicians' goals by appearing to be anti-performance. With both the table and the line of laptops as a protective barricade, the audience is not privy to the method of creating sound, nor the possibility of participating in the sound-creating, nor the possibility of disrupting or stopping the performance. According to Jacques Attali, "the game of music thus resembles the game of power: monopolize the right to violence; provoke anxiety and then provide a feeling of security; provoke disorder and then propose order."[1] In our stage presentation, FLIP succeeds in monopolizing violence and provoking anxiety, but fails to provide security and order.

In our second official FLIP performance (4/30/11 at The Laboratory), I decided to add visual performance cues by playing aggressive drum samples and physically "rocking out." Quickly regretting this decision due to its incompatibility with the visual performance aesthetics of the rest of the band, I retreated to a "normal" playing position, but still moved along with my drum samples, which constitute the bulk of my contribution to this particular improvisation. So while there is no one-to-one correlation between my mouse-clicks and keystrokes and the resulting sounds, I at least appear engaged with the same music that is perceived by the audience.

Does that make my performance any more appealing to the uninitiated audience member? The laptops are the only objects present that could be assumed to be instruments, but our interaction with these instruments is hidden. By moving to the beat, I am perhaps no more engaged with the actual production of sound than a dancer is during a Broadway show. How is anyone to know that my laptop is the one producing the drum patterns?

Since my physical movements do not carry the theatrical codes of performance, they cannot directly resolve the audience's desire for spectacle in performance. They do serve to humanize the performance somewhat, signifying that the group is engaged with the resultant sounds and assuring the audience that the group is not intending to be confrontational. Cascone writes that "The use of spectacle as a solution to the lack of visual stimuli only works to reinforce the confusion of authenticity and aura" and for the laptop to be accepted as a musical instrument, "there needs to be a recuperation of codes that move away from the use of spectacle."[3]

One such code might be performer placement; if we had played in-the-round, with the audience peering over our shoulders, the performative actions carried out by each of us would be much more clearly displayed for the audience, and any extraneous movements such as mine might evoke a more communal, rather than confrontational, experience. Another code would be in the marketing; if called a "happening" or "experience" rather than a concert or performance, the focus would shift away from the people causing sounds to be generated and toward the sounds themselves. Both situations would thwart the performer-audience hierarchy, changing from a confrontation to an invitation. *-Adam Scott Neal*

3. BEN: THE 'DRUNK' OBJECT AS AN ANALOGY TO FLIP PERFORMANCE PRACTICE

The 'drunk' object in the audio programming language Max/MSP models the basic mathematical processes behind a drunkard's walk, outputting random numbers depending on the variable arguments of range and step size. While assuming most readers are familiar with - or even better have performed - the walk, the following is a brief illustration of the process: a drunkard begins at one point on a Cartesian plane (see: bar), and moves toward a goal point (see: home); despite a varying amount of missteps, the drunkard eventually arrives to his/her goal - though not for better. The object is cute and small, and simplifies the mathematics behind the random walk procedure for a user. While providing great compositional potential, more often than not, the use of the object produces commonly predictable sonic results, normally in the hands of unknowing programmers. Whether taking this cynic viewpoint or choosing to ignore it, the process formalizes a trajectory that despite one's ideal and countless number of detours, one cannot avoid the eventual goal in-sight: success with varying degrees of failure. This balance of success and failure can only be measured, however, by the protagonist and observer's subjective metrics. It has become evident that the use of the 'drunk' object is merely an analogy for which I link my personal experiences with the laptop ensemble performance practice of FLIP. While undeniably guilty of sonic meandering, I propose that FLIP distinguishes itself from other laptop ensembles as they recognize the inevitable failures of an ideal laptop performance and devise an innovative performance practice of computer music improvisation and experimentation.

Let us take one random step back though. Not all missteps are immediately flawed. New sonic terrains can be discovered as the result of happenstance, and gleaned for future use. The marriage between computers and improvisation has long been established since the 1970's. The League of Automatic Music Composers and the Hub customized electronics such that new compositions were realized as a result of varying configurations.[5] Ensemble members improvised with the rate of data-transmission and adjusted circuitry to express their personal musical tastes. Since then,

laptop ensembles have emerged which utilize a plethora of technical advancements to aid their artistic vision. Some of these include networking for computer synchronization, alternative-gestural controllers, and visuals. With the greater availability of technology, methods for enhancing real-time computer music is inevitable. Yet this is not a route the current FLIP ensemble intends to embark on.

At the inaugural FLIP meeting, the ensemble attempted to realize one of the member's composed works for multiple laptops. Briefly, the piece required performers to toggle through a series of audio presets which altered the sonic output over a period of time. However there was a near-immediate mutiny due to the prerogative that each member felt more equipped to express their own musical interests through their own custom instruments. Following this choice, FLIP became an ensemble dedicated to the the use of an "autonomous improvisation" model for group laptop performance. Rather than realizing a pre-determined score or performing with a specific piece software, FLIP composers develop their own laptop performance environments and arrive at each performance with a variety of unique "instruments" available - sometimes instruments completely foreign to the other members. It is the belief of each FLIP member that as the sole designer of their individual instruments, they are the most qualified in exploring the sonic possibilities therein and may aptly entertain any modifications as needed during performance.

FLIP performances are infrequent, which adds to the unpredictability of public realizations. The excitement or dread shared by members is equal parts amazement and disappointment in each member's choices in developing their individual soft/hard-ware instruments and their decision to employ said instruments. There is no standardization in instrumentation, spectrum, amplitude, etc. The only possibility of variance between performances is up to the discretion of the performers and their current instrument research. In performance, I recall and execute a catalog of instruments written in Max/MSP and SuperCollider depending on real-time circumstances. These instruments vary in sonic potential. A brief overview of the mechanics of these self-constructed instruments follows: recursive algorithms designed in SuperCollider to read audio from a collection of audio buses which are then analyzed and used to determine output frequency, amplitude, and panning parameters; specific samples, playback repetitions, and processing initiated by keystroke commands; Max/MSP patches that utilize a Wacom tablet to select audio samples, playback speeds, and convolution. My improvisational discipline informs my attempts to navigate a "successful" performance or, reluctantly sink into a noise abyss. During a FLIP performance I am constantly reminded by John Bischoffs approach to electronic music: "If I had to put it into words I'd say I was drawn to a music that sounded as if you were hearing the heart of the electronics, of electricity as a material. That means a huge range of tones and noise and interruptions, unpredictable events and unpredictable control."[8] While I share this personal attitude toward improvisation toward real-time laptop music, it is not always common to my fellow FLIP members.

What is challenging about performing with FLIP is that though I may have some improvisational insight into where I hope to guide a performance, these directions may be thwarted by my colleagues. The low-thumping bass drones or tried-and-true drum beats more often than not anchor musical spaces explored by FLIP - much to my chagrin. Additionally the performance output is a stereo mix of four disparate musical ideologies which often have nothing in common except for their musical platform: the computer. As a result, the sonic output does not adequately realize my performative efforts. While FLIP performances are successful in the fact that they exist as a composite of four individual musical voices in real-time, I believe the main failure of FLIP is its inability to accurately isolate and reflect these unique musical perspectives. *-Benjamin O'Brien*

4. TRAVIS: TIMBRE, FORMAT AND FRUSTRATION

In reviewing and critiquing recent FLIP performances through the lens of "idealism and failure," the issues that present themselves most strongly include spectrum (or timbral palette) and the advantages and shortcomings of the improvisational laptop quartet format relative to other performance forces. These issues are intertwined throughout my thoughts on the ways in which FLIP has consistently failed to meet my idealistic notions of what it should be, but has rather become something that none of us really intended.

My preparation for a FLIP performance includes gathering sonic materials of many different characters — harmonic, noisy, low-pitched, high-pitched, etc. — and ensuring that I have ample means for controlling the synthesis, playback, or manipulation of these materials during a real-time improvisatory setting. My strategies for deploying this material during a performance rely upon my choice to perceive a FLIP quartet improvisation as a single auditory stream. I wish for the audience to listen to a FLIP improvisation as if it were a fully-realized piece of electronic music with a unified focus rather than four independent improvisers facing off against one another. One reason for this strategy stems from the practical manner in which FLIP has been confronting the issue of amplification. Rather than utilizing individual amplifiers/speakers to keep our sonic output streams segregated, all four of our laptops are fed into a single stereo mixer and output to a single stereo pair of speakers. As the sound of the quartet is originating in a single spatial location (and the audience has very little in the way of visual cues from the performers), the question of "who is playing what?" becomes almost irrelevant.

The choices that I make during a FLIP improvisation almost always stem from this way of perceiving the performance. As an electroacoustic composer whose output has recently taken a turn towards composing primarily acousmatic music, I am perhaps a bit hyper-sensitive toward the issue of FLIP's timbral palette. To be honest, many of the sonic materials used by the other FLIP members do not hold much interest for me as a performer/composer. Such materials are not attractive to me either due to their timbral characteristics or the manner in which they are being performed. These sounds are oftentimes monophonic or simply too narrow-band in spectrum for my tastes. When confronted with a stream of uninspiring sounds (or to be more kind, sounds that I would not personally choose for "my" music), my goal is usually to construct some sort of counterpart that will re-frame these sounds in a different context. If other FLIP members are utilizing percussive sounds or monophonic sounds in a quasi-melodic setting, I might bring in a broad-band harmonic or noisy sound to provide some sort of constant background. If presented with only midrange or high-register sounds, I might begin to add low tones in the 50Hz-120Hz range. Another strategy that I have found myself employing while trying to steer a FLIP improvisation in a direction that I find interesting is to try to be as annoying as possible. Often times a loud disruptive outburst on my part will serve to cleanse the palette and inspire the other performers to move off in new directions.

These issues have been present in all FLIP performances thus far, and will continue for as long as the ensemble remains in its current incarnation. One reason for this is simply the format and ideology of the ensemble. In contrast to many other laptop ensembles, FLIP does not perform preexisting compositions or even attempt to adhere to any particular formal scheme during an improvisation. As such, FLIP has more in common with the experimental "free improvisation" scene than it does with other laptop ensembles. The second reason is that we are all composers of acoustic and electroacoustic music who are accustomed to holding total control over our own musical output. It can be very easy to become selfish while performing in a group improvisation, and I have demonstrated my tendencies to assert some particular musical idea at the expense of others on numerous occasions.

If a FLIP performance is thus a failure relative to my own idealism of what a "good" electronic music performance should be, should it then be termed an outright artistic failure? My answer after stepping back and removing myself from the equation is no. While there are always elements in our group improvisations that I do not personally care for, I feel as if these conflicts of interest are what drive our meaningful musical interplay. What makes FLIP engaging in performance is its conflation of the laptop ensemble format with the free improvisation model. Due to the aforementioned single source of sound amplification and relative lack of visual agency for the resulting sonic events, the audience is forced to reckon with the group improvisation as if it were one entity. *-Travis Garrison*

5. SEAN: THE SILENT (FOURTH) PARTNER

As a laptop improviser with FLIP, I am simultaneously a performer and my own audience; I try to listen attentively to not only myself, but also to the other members of FLIP, as I gauge my sonic contribution moment by moment. From the composer perspective, laptop performance is relatively straightforward: I use the instrument in realtime similar to how I compose with it; I take advantage of the laptop's inherent separation between control and sound synthesis to precompose "out of time" sonic structures directly into the fabric of the instrument through software design. As I improvise during a FLIP performance, I am of course restricted to the aspects of music which exist "in time" (as Cage would say, issues of form and material).

From the audience perspective however, laptop performance is more problematic. I know I am performing; but how does the audience know? This suspicion is obviously the basis for the trite joke about laptop musicians checking their email, or playing sound without "playing." Joking aside though, this is the heart of the matter. My ability to identify with the audience perspective (in part, because I am myself an audience to the other members of FLIP) forces me to become aware of one's inability to validate laptop performance according to the traditions established by acoustic instruments. Ultimately, as I shift my perspective from improviser/performer to audience member there is a movement away from musical concerns (i.e. what sounds should I make now?) towards theatrical ones (i.e. what should I do right now to show that I'm making a sound?).

If such a shift in perspective places greater emphasis on how we engage with the instrument of sound production rather than the crafting of musical experience, then any attempt to appease audience unease toward the perceived inauthenticity of laptop performance must acknowledge the instrument as fundamentally different. To reiterate Cascone's assessment, "audiences experience the the laptop's use as a musical instrument as a violation of the codes of musical performance."[4] Fundamentally, it is something about the laptop: how we engage with it as performers and how it is received by audiences, which needs to be (re)addressed in conjunction with the context of its activation as an instrument.

Our performative actions upon the laptop as an instrument are couched in the history of instrumental concert performance. As Timothy Jaeger describes, "the bodily restraint, seriousness of purpose, and lack of ornamentation in the performance of this type of music [laptop music] is related to the European classical tradition of the eighteenth century."[7] While this "seriousness of purpose" has served

instrumental concert music well, or at least its conventions have "created a polarized axis of performer and audience... [creating] a distance or aura which empowered the performer with an authenticity, that helped create value in their craft,"[3] such a distance paradoxically *devalues* the craft involved in laptop performance. The devaluing occurs because we (FLIP) know, like we know our audience knows, that computer-generated or reproduced sound is displaced sound. Its source is not a physical body that is here, or present in performance; it is therefore necessarily virtual in origin, or (to borrow some Lacanian terminology) not Real. Such displaced sound is immediately understood as an engagement with the Symbolic and Imaginary realms of perception and representation, and it by-passes the need for an embodied mode of presentation or performance. If a laptop performance is heard through loudspeakers, in the same way our favorite pop music is listened to through headphones plugged into an iPod, why objectify through conventional performance an otherwise displaced sound source? From the audience perspective, the only thing being demonstrated is that sound can come from loudspeakers ostensibly generated by a laptop. That, "there is no visible causal link apparent between the performer's gestures and the resulting audio,"[12] belies the fact that we know there could very well not be a link at all. Therefore, our suspicion of an instrument that doesn't appear to physically do anything (i.e. change its position, interact with other physical bodies) cannot be reduced to an unfulfilled desire for visual stimuli in a performance setting. Rather, our suspicion points to an intuitive awareness of the metaphysical distinction between embodied sound and virtual sound as being presented as insignificant.

Tad Turner, discussing a laptop performance at an art gallery opening (ostensibly supporting the purchase of the artwork), provides an anecdote which highlights this intuitive awareness clearly:

> Michael Farley, for example, was invited to perform at a New York gallery opening for computer-generated visual art. Amidst the wine and cheese, the gallery goers were "the worst. They don't ask, 'Where's the band?' They ask, 'So what program are you running?' while you're in the middle [of] performing."[11]

Any attempt that Michael Farley is made to put on a good show or demonstrate virtuosic skill on his instrument was completely devalued through the conjunction of laptop as instrument and performative convention. The question, "what program are you running?," is a double bind. Either Farley responds that it is some commercial music application, which then in turn functions as a stand-in for the music itself (in effect, directly commodifying the performance), or he responds that he's checking his email and Farley's bluff has been called — and here's the kicker — because we all know that it is possible. This is what Žižek would describe as an *unknown known*: "[something] we don't know that we know."[13] But despite the fact that both performers and audience implicitly realize the possibility of non-performance, we proceed with conventional performance anyway. In effect, laptop performance discounts the significance of our awareness to the fact that a not-fully-engaged performance practice can easily be presented as "authentic."

The devalued "aura" associated with laptop performance can be overcome via two approaches: changing the instrument or confronting the art of performance. Through the first approach, we attempt to modify the instrument (laptop) to conform more rigorously to the stipulations of convention and virtuosic display (read: spectacle). However, while the use of a hardware controller for interfacing with the laptop provides a heightened sense of performer agency, it does nothing for the laptop itself. Even an unbound degree of control, gesturality and precision fails to overcome our experience-based understanding of the distinction between hardware and software. Perhaps twenty or thirty years ago that distinction would be lost on some people, but not now, especially among younger generations who have grown up in a computer literate society. By using a controller, the no-longer-laptop performer reinforces the bifurcation of objectified performer and consumerist audience, as established through concert hall convention. This reinforcement masks but does not change our underlying awareness of a devalued laptop "aura."

The second (and in my estimation, more fruitful) approach to overcome the devalued "aura" of laptop performance is to confront the convention of performance directly, highlighting the absurdity of our expectation for authenticity considering an instrument that is, by its very design, operative only in virtual spaces. The possibility of a laptop performer not being fully engaged is an opportunity (afforded by the laptop itself) to choose, or in fact vary, one's level of performative engagement on a moment by moment basis as an improviser. To do so allows for a continuum of engagement to be explored as a means of recasting 18th century performance conventions. The codes of performance are re-evaluated by disclosing a shared understanding of what the instrument does (in a general sense). We know the instrument can make sound without constant interaction; so let it (a little). This is a way to *play* the laptop, and then *not play*. To demonstrate through performance that not playing is not a worry accentuates the agency of the improviser to operate through the laptop in a musical capacity. The serious acknowledgement of the possibility for "inauthentic" performance, as such, productively undermines the very notion that the laptop, and by extension laptop performance, can be validated in accordance with the authenticity demanded by the codes of conventional music performance.

While we may not know what program someone is running, to know to ask the question underscores an intuitive understanding of what a laptop does. Therefore, by per-

forming in a way that acknowledges that one doesn't always have to be physically doing something to the laptop to get sound out of it (or vice versa), allows for the performer to establish new codes of performance, based on the removal of authenticity as a valid rubric for criticism.

This is of course not a new idea. I am reminded of Gregory Bateson's illustration of such an instance of tempered behavior functioning on a meta-communicative level in describing animal play, stating that, "the playful nip denotes the bite, but it does not denote what would be denoted by the bite"[2] (i.e. combat). Following Bateson, demonstration of the momentary choice to not perform one's laptop operates in similar fashion. In fact, if we understand "performing on a laptop" to be commensurate with the word "play," Bateson goes on to say, "the actions of 'play' are related to, or denote, other actions of 'not play.'"[2] The audience for a laptop performance is worried about "not play," or the potential for an utter lack of performance (combativeness). Implicitly, we recognize and hold as a real possibility this lack of performance, as denoted by our understanding of what laptops are capable of (email checking) and our expectation of conventional performance. By showing a tempered version of "not play" (a nip), laptop improvisers/performers can establish a new understanding of performance on a meta-communicative level.

FLIP is in fact a perfect playground for experimenting with these ideas. While I am never quite sure which one of my compatriots is currently responsible for the abysmal state of things at any given moment, making sound does little to change the aggregate music. My composerly desire to direct FLIP's music is ostensibly a self-aggrandizing delusion, but my ability to affect the audience's experience of it is not; I can demonstrate my choice to abstain. I can turn my volume down, have a drink of my beer, make a momentary contribution, and then be silent and inactive to highlight the immediacy of not only the politics, but the music. In the context of FLIP, these are not drastic actions of "not play," because they are tempered by the apparent continuity of engagement demonstrated by the rest of the ensemble at any given moment.

Ultimately, each member in FLIP can take advantage of the fact that we are a league, not a team. A team is cooperative; we are competitive. We are a league wherein four different members are constantly vying for their own musical prerogatives. In order to show the true interaction that is taking place behind the computer screens we merely have to demonstrate that the full potential to not perform is not operative. We may "not perform" a little, but the effect of doing so dispels notions that we should all be worried that someone just might be (gasp) checking their email. Because we know if they do, it is for a reason; it is purposeful within a new set of codes for performance, which don't stipulate that performers act and audiences listen "as if" the laptop were a cello. In laptop ensemble music, the insistent accretion of sound does nothing to acknowledge the difference between the laptop and acoustic instruments. But the removal of sound, and the disengagement of oneself from making sound can go a far way in establishing a meta-communicative basis for genuinely engaging (from the audience perspective) sonic play. *-Sean Peuquet*

6. REFERENCES

[1] J. Attali, *Noise: The Political Economy of Music*. Minneapolis, Minnesota: University of Minnesota Press, 1985.

[2] G. Bateson, *Steps to an Ecology of Mind*. Chicago, Illinois: The University of Chicago Press, 1972.

[3] K. Cascone, "Laptop music—counterfeiting aura in the age of infinite reproduction," *Parachute*, vol. 107, pp. 52–60, 2002.

[4] ——, "Grain, sequence, system: Three levels of reception in the performance of laptop music," *Contermporary Music Review*, vol. 22, no. 4, pp. 101–104, 2003.

[5] S. Gresham-Lancaster, "The aesthetics and history of the hub: The effects of changing technology on network computer music," *Leonardo Music Journal*, vol. 8, pp. 39–44, 1998.

[6] P. Hegarty, *Noise/Music: A History*. New York, New York: Continuum, 2007.

[7] T. Jaeger, "The (anti-)laptop aesthetic," *Contemporary Music Review*, vol. 22, no. 4, pp. 53–57, 2003.

[8] D. Kahn, "A musical technography of john bischoff," *Leonardo Music Journal*, vol. 14, p. 77, 2004.

[9] N. Smith, "The splinter in your ear: Noise as the semblance of critique," *Culture, Theory, and Critique*, vol. 46, no. 1, pp. 43–59, 2005.

[10] C. Stuart, "The object of performance: Aural performativity in contemporary laptop music," *Contemporary Music Review*, vol. 22, no. 4, pp. 59–66, 2003.

[11] T. Turner, "The resonance of the cubicle: Laptop performance in post-digital musics," *Contemporary Music Review*, vol. 22, no. 4, pp. 81–92, 2003.

[12] M. Zadel and G. Scavone, "Different strokes: a prototype software system for laptop performance and improvisation," in *Proceedings of the 2006 International Conference on New Interfaces for Musical Expression*. Paris, France: NIME06, 2006, pp. 168–171.

[13] S. Žižek. (2008) Censorship today: Violence, or ecology as a new opium for the masses. [Online]. Available: http://www.lacan.com/zizecology2.htm

MIDDLE PASSAGE: RECLAIMING WHAT IS LOST AS PERFORMANCE AND PRACTICE

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ABSTRACT

Middle Passage: Reclaiming what is Lost was written for and performed by the Princeton Laptop Orchestra in the spring of 2010. The work began as a Concerto for Laptop Orchestra and my own instrument, The Tape Machine (a live analog looper) and has evolved into something broader. It currently exists both as a performance work and as a workshop practice that explores grief and loss. It is through this unconventional use of the laptop ensemble that I have come to have a deeper understanding of this piece and the musical, technological, and cultural potential of laptop ensembles.

1. INTRODUCTION

The laptop orchestra is an artistic medium that balances technological and musical possibility. In this paper, I will begin with a theoretical discussion of this statement and continue by applying these theories to an analysis of my composition *Middle Passage: Reclaiming what is Lost.* My discussion is framed by two main objectives. My first objective is to recognize and support the broad diversity of what laptop ensemble music can be. This breadth includes and is not limited to musical style, performance location, engagement of player, types of controllers, and use of technology. My second objective is to explore why the laptop ensemble is a particularly rich and important form of artistic expression for contemporary society.

What I have to offer the laptop ensemble community is a unique perspective shaped by a lifetime of choral singing, extensive training as an acoustic and electronic music composer, six years of experience writing and performing laptop ensemble music, as well as extensive studies in political science, social theory, and embodiment practices. My discussion will be guided by my compositional commitment to the idea that music has social and political significance. A composition demonstrates a way of interacting and it becomes a form of modeling social possibility or reality. Because the laptop is such a powerful tool, the laptop orchestra becomes an especially interesting socio-musical phenomenon that represents our social relationships as well as our relationship with technology.

2. TECHNOLOGICAL POTENTIAL

Clearly there is immense technological and musical possibility within the laptop orchestra. At the heart of this diverse potential is the laptop. The laptop is more than an instrument: it can be a conductor, composer, performer, listener, or any combination of the above. As an instrument, the laptop can synthesize sounds, use samples, or take live input and can process or combine any of these sound sources. The laptop's power and versatility is based in its ability to abstract sound from its source. In acoustic music, biomechanical energy directly transfers to sound energy. For example, the weight of the bow being pulled across a violin string directly creates the tone of the instrument. Electronic instruments can be designed to mimic this coupling of physical to sonic energy with the use of various sensors and specific programming, but these instruments are rarely as nuanced or sensitive as an acoustic instrument. In "electronic music, electricity is independent from haptic biomechanical energy...the controller is decoupled from sound production."[1] In other words, the laptop allows for disembodied sound production.

Sounds are not only free from embodied physical production, but also free from time, place, sound source, quality, tone, musical style, tempo, or any attribute can become a variable through synthesis, processing or sampling. The ability to mash up different musical styles, time periods, and players as well as transform their ability creates immense musical possibility and meaning. Sonic energy is no longer bound to an embodied source.[2] We can pump up the volume with the adjustment of a knob without breaking a sweat. Networking allows for collective compositional control where any compositional parameter can be controlled by any connected laptop. Musicians may play the same instrument while being thousands of miles

[1] Leman, M. *Embodied Music Cognition and Mediation Technology*. Cambridge, MA: The MIT Press, 2008, pp.163.

[2] Except in the marvelous example of *Our Lady of Detritus (2009)* a piece by Jill Sigman with music by Kristin Norderval where all the energy needed for the piece is made by the audience or performers during the piece. Perry Cook and Skot Smallwood have also done work with solar powered instruments.

apart. Sound output also becomes a variable where a laptop may send its sound to a specific location or many locations or nowhere. Multiple players may be run through a single PA system or each player may have their own speaker system. All this allows for immense compositional and technological possibility.

3. MUSICAL POTENTIAL

For me, musicality is defined by the presence of listening, interaction, response, and virtuosity, or the potential to improve any of the previous elements. At the root of these attributes is the ability to learn about sound and sounding, both alone and with others. If musical potential is dependent on our ability to learn about sound,[3] technological advances that break the innate relationship between biomechanical energy and sound energy disrupt our embodied learning. We can still appreciate the physics of sound, but sound is no longer directly related to our body. This abstraction of sound energy means that we are not given the same kind of clues about how the sound is made or what it means. The violinist who forcefully pulls the bow across the strings making a fortissimo sound with a strident tone coupled with aggressive physical action communicates tension and force within a sonic and visual context. Here, sound and physical gesture complement each other.[4] This complementary relationship between body and sound has become very important to musical meaning creation and communication. How then, do we understand what music means without these physical clues?

4. RECLAIMING WHAT IS LOST PERFORMANCE

While struggling with these questions, I wrote *Middle Passage: Reclaiming what is Lost* for the Princeton Laptop Orchestra (PLOrk). I decided to try to create a ritual practice for laptop orchestra inspired by Maya Deren's study of Haitian Voudoun practices, *Divine Horsemen: The Living Gods of Haiti*. Specifically, I was interested in the ceremony of reclamation.

> The gros-bon-ange [soul of a person], as the repository of a man's history, his form and his force, the final resultant of his ability, intelligence and experience, is a precious accumulation. If, after his death, his descendants were able to provide this disembodied soul with some other means of manifestation to substitute for the flesh which perished, they could salvage this valuable legacy. One of the major Voudoun rituals is the ceremony of retirer d'en bas de l'eau, the reclamation of the soul of the deceased from the waters of the abyss.[5]

My goal was to construct a modern reclamation ceremony. My compositional choices were guided by my decision to prioritize body language and choreography that would promote the idea of ritual. I used archetypal movements to communicate a world of conjuring and calling. I structured the piece around two formal elements, the circle and the line, both of which are used in traditional Voudoun practices [4]. Finally, I tried to take advantage of the benefits of abstracting sound from its physical source (such as the way this represents the disembodied spirit) while supporting musical behaviors such as listening and responding.

4.1. The Rope Instrument

Figure 1. The rope instrument in *Middle Passage.*

In *Middle Passage*, the circle first arises with the use of a rope approximately twelve feet in diameter. The rope is a collective controller. It is attached to six Game Trak Tether controllers placed evenly under the rope. Each tether controller sends information to an individual laptop, hemispherical speaker, and subwoofer triggering and controlling playback of various samples. There is no networking of the laptops. All coordination is created through the rope controller. The piece begins with the entrance of the ensemble, humming a single tone, lifting the rope, and pulling the rope from side to side with resistance, as if pulling to lift an anchor. Through practice, the PLOrk ensemble perfected the slow, even, collective pull needed to play the rope instrument and the specific body language that I was looking for. In my instrument design, I was aiming for a dynamic relationship between

[3] This learning is not limited to sonic input, but formed through vision, touch, movement and all embodied senses.

[4] According to Nicholas Cook, complementary movement and sound communicates clearly to an audience and is one of the ways that we interpret multimedia interaction [2].

[5] Deren, M. *Divine Horsemen: The Living Gods of Haiti*. New York: McPherson and Company, 2004, pp. 27.

collective movement and sound production where getting the rope to sound would not be automatic. I was also hoping to support an attention to movement, so that they would have to have a strong collective awareness of movement, change of direction and rate to keep the rope taut and the instrument sounding.

The rope instrument reconnects physical energy with sound energy in two ways. The first is that the sound originates as acoustic singing. The audience understands the sound as coming from our physical bodies and rather than presenting a foreign sound, the rope plays through a sample that reinforces the acoustic singing so that it is not completely clear what balance between acoustic and sampled sound you are hearing. There is a period of time where the audience believes the sound to be embodied when it is not. Secondly, the movement of pulling the rope mimics the tension and resistance found in string instrument sound production. It is reminiscent of the movement used by players of Ellen Fullman's Long String Instrument. We understand tension and friction as a sounding movement. We also understand this as a listening movement. We know that the movement must happen in unison for the rope to remain taut. There is a musical subtlety implied by the required listening and awareness of other ensemble members. Finally, it is a working movement that has cultural and mythic significance denoting hard, collective work, like pulling up an anchor or sail. As the piece aims to call a spirit from the waters of the abyss, this movement seems fitting.

4.2. The Dualvocoder Instrument

Figure 2. Tether pole extensions in *Middle Passage.*

Over time, the rope sample crescendos until it is the dominant sound so that what starts as human voices becomes otherworldly. The piece continues with vocal solos, a solo by my live analog cassette looper, "the tape machine," and finally the addition of pitch consistent sampling. For this sampling, I used an instrument developed by Dan Trueman called the "dualvocoder." This instrument uses delay lines to play through a sample so that the playback speed can be varied without pitch shifting the sample. The length of the tether string (z axis) controls where the player is in the sample playback. Sonic moments can be elongated, repeated, frozen, or played quickly. The dualvocoder is an instrument that is immediately playable and something that players can practice and perfect [3]. The tether controller inspires a fluid and graceful duet between player and tether line. As the player improvises through the sample playback, their intent listening is performative and musical. When two dualvocoders are played simultaneously, the players are both listening and watching, responsive to sound and movement. This observation and responsiveness is innately musical. The player is learning about the instrument, the other player, their own body, and the body's of others while performing. Embodied Cognition Theory suggests that this learning through interaction and a cycle of observation and response is central to how meaning is created.[6] The dualvocoder tether line is the linear structural element of the piece. The tether line dynamically interacts with the circle. In the end of the piece, players use poles to extend these tether lines so that the heightened line visually balances the rope circle.

5. RECLAIMING WHAT IS LOST WORKSHOP

After the premier of *Middle Passage: Reclaiming what is Lost*, I did not feel that I had answered my original compositional challenge to create a piece that could call a spirit from the waters of the abyss. Following the suggestion of fellow composer MR Daniel, I designed and facilitated a workshop on loss based on *Middle Passage*. The workshop was held at the Oakopolis Gallery in Oakland, California in the summer of 2010. I asked participants to bring a sonic memory (5-10 seconds) and a physical object relating to their loss. I taught the basic elements of playing the rope instrument and, during the break, recorded their sonic memories and prepared the sound files to be played by the dualvocoder. We began by placing our physical objects in the center as an altar. We publicly stated whom we were calling. Then, we began singing the drone and pulling the rope. When this became strong, one by one, workshop members played the dualvocoder instrument in the center of the circle as an aural altar. It was a very different piece. There was an intention to the pulling of the rope and singing that felt both cathartic and supportive as we each entered the circle. The attention and listening to others was not limited to sound and movement, but also included an emotional listening. The memories from the center aural altar were beautiful. They felt more like thoughts or hopes, as if we were hearing the inner voice of the player. I had a deep

[6] Johnson, M. *The Meaning of the Body: Aesthetics of Human Understanding*. Chicago: The University of Chicago Press, 2007.

feeling of connection with the ensemble members and my personal loss as well as the loss of others.

The workshop allowed for a sharing of the grief experience that was not language based, but centered in movement and sound.[7] The rope supported connection without the discomfort of direct contact. The movement and exertion demanded while playing the rope became a physical and sonic mantra that helped to focus each individual and the collective ensemble energy. The dualvocoder instrument provided personal input into the sonic landscape. My compositional focus on connection and listening helped me to make technological and musical choices that clearly established the role of each player and what was expected of their participation. This experience gave me a broader view of the potential for *Middle Passages: Reclaiming what is Lost* and of laptop ensemble works as performance and ritual practices.[8]

6. CULTURAL POTENTIAL

Music has a fascinating way of communicating very subtle cultural values. As a relatively new musical practice, I think that there is a lot of possibility for diversity in laptop ensemble music within some of these cultural signifiers. Most people I talk to have no idea what a laptop orchestra is and no preconceived ideas about where we should be playing, what kind of music we play, or how we play that music. It is a beautifully blank canvas! We, as laptop ensemble composers and players, get to explore the cultural potential of the laptop orchestra, and this is important. It is important because these pieces model a balance between the spirit and our mechanical tools and this is a relationship that we have struggled with for centuries.[9] There is an exciting moment of cultural meaning when, in a laptop ensemble piece, people bend down to really listen to their laptops or, as in Perry Cook's *Lux Aeterna,* they gracefully tilt the laptop, singing to it and to each other. This creative and playful interaction with the laptop reinvigorates both what the laptop can mean and how we use technology and our collective resources to make something beautiful together.

7. REFERENCES

[1] Benjamin, W. *Illuminations.* New York: Schocken Books, 1968.

[2] Cook, N. *Analysing Musical Multimedia.* Oxford: Oxford University Press, 1998.

[3] Cook, P. "Principles for Designing Computer Music Controllers." *ACM CHI Workshop in New Interfaces for Musical Expression (NIME),* Seattle, April 2001.

[4] Deren, M. *Divine Horsemen: The Living Gods of Haiti*. New York: McPherson and Company, 2004.

[5] Gendlin, E. *Focusing.* New York: Bantam Books, 1978.

[6] Johnson, M. *The Meaning of the Body: Aesthetics of Human Understanding*. Chicago: The University of Chicago Press, 2007.

[7] Leman, M. *Embodied Music Cognition and Mediation Technology*. Cambridge, MA: The MIT Press, 2008.

[8] Levine, P. *Waking the Tiger: Healing Trauma: The Innate Capacity to Transform Overwhelming Experiences*. Berkeley: North Atlantic Books, 1997.

[7] Research in Somatic Psychology by Eugene T. Gendlin, Peter A. Levine and others suggests that psychological trauma can be captured in the body and must be released physically as well as psychically [5 and 8].

[8] LOrk pieces are especially accessible as ritual works because they are often constructed for elementary players so that the instruments can be adequately mastered within a limited amount of time.

[9] Stories like Icarus, John Henry, and 2001 are examples of attempts to understand this balance.

STRATEGIES FOR STRUCTURED *ORK PERFORMANCE CHOREOGRAPHY: INTEGRATING TAIJI MARTIAL ARTS INTO L2ORK REPERTOIRE

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ABSTRACT

One of the increasingly important challenges in the laptop orchestra performance practice is performers' physical presence and choreography. Relying primarily on hyperinstruments that offer unprecedented flexibility, and yet by doing so lack preexisting performance tradition and supporting metrics, laptop orchestra composers need to navigate a minefield of gestures that have an inherent association with a non-musical activity and thus may be inadequate in conveying musical tension to the audience. More so, commonly without a preexisting performance practice novel gestures need to be clearly annotated in the score. To address these challenges the Linux Laptop Orchestra has sought an increasingly structured approach to physical choreography, culminating with the integration of elements of Taiji mind body practice and supporting dynamic and discipline-agnostic performance score infrastructure. Based on the feedback from performers and audience alike, L2Ork has attained a more engaging stage presence, an increase in ability to convey tension and individuality, as well as means for audience to observe and assess emerging performance practice. In the following presentation we wish to share lessons learned through this process and offer strategies that may facilitate a wider adoption of this approach within the laptop orchestra community and beyond.

1. INTRODUCTION

One of the advantages of the interactive computer music performance interfaces is their inherent flexibility. Each computer-based hyperinstrument [1] can vary dramatically from piece to piece in terms of its interaction techniques, supporting hardware, performance practice, and ultimately the ensuing sound. When placed within the context of a laptop orchestra, this flexibility also poses some unique challenges. Unlike smaller setups that typically base its stage aesthetics on a DJ-like free-form improvisation, the very use of the the word “orchestra” imposes a new set of expectations and responsibilities we commonly associate with a large organized and coherent group of live performers. Consequently, one of the increasingly important challenges is performers' physical presence and choreography. Hyperinstruments allow for a wide array of performance practices and yet by doing so lack preexisting observable skill and virtuosity metrics, particularly when associated with non-traditional music material. More so, unlike traditional instrument performance practice with its rich vocabulary of gestures that further strengthen the emotional impact, convey the difficulty and tension associated with the material, and typically do not require explicit annotation within the context of a music score, laptop orchestra composers need to navigate a minefield of gestures that have a strong preexisting association with a non-musical activity and thus pose a problem in terms of conveying musical tension to the audience (e.g. typing on computer keyboard is more likely to be perceived as typing an email rather than performing an instrument) and furthermore require clear annotation of their use in the score. To address these challenges the Linux Laptop Orchestra (L2Ork) [2] has sought an increasingly structured approach to group choreography.

L2Ork relies exclusively on Nintendo Wiimote [3] and supporting extensions as its input device. The decision to use Wiimotes was initially to ensure compatibility with other, mainly Macintosh-based *Orks, as the Linux-based notebooks used by L2Ork do not provide embedded accelerometers. Inadvertently, driven by Wiimote's rugged design, greater range of body motion, haptic feedback potential, and independence from stationary hardware, a new performance aesthetic emerged. Following early concepts that borrowed largely from traditional instruments (e.g. bowing motion and positional mallet-like hits) and allowed for the design and production of the supporting software frameworks, it quickly became apparent that to project a convincing stage presence and coherence, physical motion needs to be carefully cataloged and controlled. While devising unique piece-specific gestures (e.g. heartbeat in Half-Life for L2Ork and solo female narrator) continued to be an important aspect of the overall choreography, the majority of the effort shifted towards the integration of well established choreographies. Taiji (Tai Chi) martial art and mind body practice proved to be an ideal choice for its fluid, broad, and by and large

flexible set of motions. More so, given that a part of L2Ork's mission focuses on outreach in K-12 education, a growing body of research in Taiji's mind body benefits [4,5] further enhanced its potential to seamlessly deliver a fusion of music, technology, science, physical exercise, attention, and focus [6].

2. IMPLEMENTATION

During the integration the ensemble faced a number of challenges. One was identifying gestures that are expressive, engaging, flexible enough to encourage individuality while ensuring consistency, clearly exhibit connection between the sound and motion, and yet are not too difficult as to prevent participants from producing pleasing and consistent results. Considering that L2Ork attracts students from across the campus, many of whom have no prior musical and/or choreography experience, there was a need to devise an interactive score delivery system that would convey both music and gesture information in a clear and concise format without relying upon traditional notation. The system also required a supporting set of rehearsal tools that would facilitate practicing isolated sections and scrubbing through the work's timeline from both the central computer and individual stations. Latter could be used for practicing parts outside group rehearsals. Finally, the system needed to be flexible enough to accommodate seamless transitions between highly structured and improvisatory sections. For this purpose a dynamic score reader and follower was devised using pd-l2ork (L2Ork's unique version of Pure-Data) [7]. The resulting system provides information on desired motions, their duration, dynamics, and other expressive parameters. Relying upon Wiimote's rumble feature the system also offers integration of haptic feedback to facilitate learning as well as monitoring of relevant parameters, such as beat, tempo, strength of a particular action, etc.

The ensuing choreography has added a new dimension to performance, requiring streamlining of other aspects of the input interface to abate the learning curve. The first two pieces written in 2011, Serene and Rain, rely exclusively upon the Taiji choreography. Shedding complex digital switches and the use of Nunchuk whose dangling wire limited independent movement of the arms in favor of the MotionPlus gyro sensor the system was able to provide more reliable readouts of sweeping Taiji gestures, particularly the ones executed at constant angular speeds. The streamlining of complex controls into fewer, more powerful and easily juxtaposed states in conjunction with the analog body motion has resulted in greater expressive bandwidth and observable virtuosity potential.

3. CONCLUSIONS

Based on the feedback from performers and audiences alike, the said transition has helped L2Ork attain a more engaging stage presence, an increase in ability to convey tension and individuality, as well as means for audience to observe and assess emerging performance practice. Furthermore, hyperinstrument's standardization has allowed us to attain greater level of proficiency, paving way towards metrics for good performance practice and virtuosity. We anticipate the newly established foundation will in the long run help audiences develop a better understanding of the said metrics and with it sophistication necessary for the assessment of virtuosity.

4. ACKNOWLEDGMENTS

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5. REFERENCES

[1] Machover, T., and J. Chung. (1989). "Hyperinstruments: Musically intelligent and interactive performance and creativity systems." *Proceedings of the International Computer Music Conference*, Columbus, Ohio, United States of America.

[2] Bukvic, I., T. Martin, E. Standley, and M. Matthews. (2010). "Introducing L2Ork: Linux Laptop Orchestra." *Proceedings of the New Interfaces for Musical Expression* (NIME), Sydney, Australia.

[3] Controllers at Nintendo :: Wii :: Console, http://www.nintendo.com/wii/console/controllers. Last accessed January, 2011.

[4] Esch, T., J. Duckstein, J. Welke, and V. Braun. (2007). "Mind/body techniques for physiological and psychological stress reduction: stress management via

Tai Chi training - a pilot study." *Medical Science Monitor* 2007, 13: CR 488-49.

[5] Klein, P., and W. Adams. (2004). "Comprehensive therapeutic benefits of Taiji: A critical review." *American Journal of Physical Medicine & Rehabilitation*, 2004, 83: 735-745.

[6] Hernandez-Reif, M., T. Field, and E. Thimas. (2001). "Attention deficit hyperactivity disorder: Benefits from Tai Chi." *Journal of Bodywork & Movement Therapies*, 2001, 5: 30-3.

[7] Virginia Tech Department of Music L2Ork - Linux Laptop Orchestra, http://l2ork.music.vt.edu/main/?page_id=5. Last accessed March, 2012.

COMPOSING FOR AND PERFORMING WITH IPADS

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ABSTRACT

This presentation will showcase "Touch," a Faculty iPad Quintet at the University of South Florida. The ensemble formed shortly after the release of the first iPad and has now presented a number of programs both on and off campus including a concert and workshop at a state music education conference. Touch serves both as a live performance ensemble and as a model of alternate performance for music education students at USF. Music at Touch concerts has ranged from Mahler to Lady Gaga and also includes original collaborations with students and faculty from dance, theater and video. The session at SLEO will examine both the compositional processes and performance practice used by Touch members. A video example from a Touch concert can be seen at http://www.youtube.com/watch?v=Mf87gB7fieI&feature=youtu.be

EVALUATING COLLABORATIVE LAPTOP IMPROVISATION WITH LOLC

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ABSTRACT

This paper discusses LOLC, a text-based collaborative music improvisation system for laptop ensemble developed by the authors. The system is contextualized in terms of related work and the specific motivations and goals for the project, and its design and implementation are explained. The paper then evaluates LOLC in the context of a recent performance by professional classical musicians with minimal computer experience. Using qualitative data from interviews with the performers and quantitative data from server logs, the paper considers the degree to which LOLC facilitated collaborative improvisation among the musicians, and the ways in which using LOLC differed from more traditional modes of collaborative instrumental musical improvisation.

1. INTRODUCTION

Textual performance interfaces can offer a unique environment for collaborative musical improvisation in laptop-based musical ensembles. They can facilitate efficient, flexible communication among ensemble members by supplementing traditional channels of aural and visual communication among members with dialog across digital networks that includes data sharing, time synchronization, and chatting. Such networked communication can also be persistent, enabling musicians to trace back through communication rather than relying solely on their memory of how a performance has transpired.

While many live coding languages do facilitate such text-based interaction across an ensemble [5,3], most are ill-suited for larger laptop ensembles and few correspond to improvisational modes in more traditional ensembles.

We designed and developed LOLC [8] to take advantage of the unique potential of text-based performance environments in larger-ensemble collaborative improvisation and to build upon the rich history of collaborative improvisation in jazz and avant-garde musical styles. In LOLC, musical patterns are coded symbolically and shared automatically, providing a foundation through which laptop musicians can effectively improvise and collaborate by borrowing and transforming the material created by others in the ensemble.

We also wanted to make LOLC accessible to non-programmers, including skilled musicians without any experience in programming or computer music. LOLC is thus deliberately limited in complexity and scope: it is not a Turing-complete programming language and consists entirely of single-line expressions.

In this article, we review the related work upon which LOLC builds and we outline the goals, design and implementation of the system. We then evaluate LOLC in the context of a recent performance by an ensemble of professional classical musicians who had no background in computer programming and little or no background in computer music. We consider the degree to which LOLC facilitated collaborative improvisation among the musicians, the degree to which LOLC was accessible to non-programmers to learn, and the ways in which using LOLC differed from more traditional modes of collaborative instrumental musical improvisation.

2. RELATED WORKS

The design and implementation of LOLC was influenced by existing models for collaborative text-based laptop performance and by approaches to collaborative improvisation in other types of ensembles.

Laptop-based musical ensembles can often collaborate more effectively when they share a common clock and code and/or music over the network. Several live-

coding environments implement such collaboration features over a local–area network. Rohrhuber's JITLib [5] and Sorensen's Impromptu [3], for example, enable clients to share and manipulate dynamic objects or variables over a network.

Instead of sharing dynamic objects or variables, some researchers have suggested an environment that enables users to share actual code fragments among members of the ensemble. A design document for the Co-Audicle [21] supports such exchange with a client-server or a peer-to-peer model. JITLib [5] implements text chat functionality and enables musicians to interpret code directly on each other's machines [18].

Another notable approach in collaborative laptop performance is that many ensembles do not use standardized tools among all performers. Instead, they simply define a shared protocol for communication. The Hub [4], for example, defined a new protocol for the ensemble with each piece they developed, but each musician used their own software to perform it.

The Hub's work Borrowing and Stealing offers an intriguing model that served as a direct inspiration for LOLC. Instead of sharing code or variables, members share music. In the piece, a shared data store maintains symbolic representations of musical fragments created by each player. Musicians then retrieve the fragments created by other players, manipulate them, play them and store the transformed version in the database. LOLC follows this approach upon which musicians can more easily borrow and recreate the materials of other ensemble members.

In addition to the ideas of live coding languages, LOLC was influenced by collaborative improvisation in other types of ensembles. Many composers have created structured strategies for ensemble improvisation in their works. Some of the works include gestures to give players instructions on how to improvise [22]. In Virtual Concerto [11], sections of the orchestra improvise together, following a matrix of instructions. Similar approaches have been proposed in ensemble-based improvisation pedagogy; a "dominoes" exercise, for example, asks players to sit in a circle and play in sequence, closely imitating the gesture of the person preceding them [1].

Many ethnomusicologists have characterized group interaction among improvising jazz musicians as a conversation: "the exchange of the [musical] idea not only established an abstract succession of sounds and rhythms but linked [the musicians] as musical personalities … at a particular moment in time" [15]. Berliner describes how musicians respond to each other, particularly when trading short improvised phrases, noting how "musicians pursue a middle ground that satisfies their desire for both continuity and change by borrowing material from one another and transforming it" [2].

3. DESIGN AND IMPLMENTATION OF LOLC

3.1.Goals and Design Principles

The main goal of LOLC was to create a text-based performance environment to facilitate collaborative improvisation in a laptop ensemble by sharing all musical materials. Furthermore, we wanted LOLC to be readily accessible to novice programmers and even non-programmers. In connection with this second goal, LOLC is not intended to be a full-featured computer music language like ChucK [20] or SuperCollider [13] or even necessarily a language at all. For instance, it uses pre-recorded sound files as musical building blocks instead of supporting sound synthesis or signal processing.

To facilitate accessibility, we designed interaction among musicians to focus on sharing musical content rather than computational content. All pattern definitions are based on the symbolic representation of rhythmic, dynamic, and sound-source information. This makes it easier for musicians to re-use and transform the material they hear others playing. In addition, all LOLC expressions are a single line in length, and there are only two expression types other than chat messages: pattern definitions and scheduling operations.

Like many collaborative performance tools, LOLC maintains a shared clock and a shared library among musicians. Players synchronize by scheduling patterns to play at a specific beat and measure in the future. Whenever a pattern is defined, it is automatically shared with all other clients on the network. Once a pattern is defined, it is final and immutable in order to facilitate the creation of derivative patterns.

3.2.Pattern Creation

There are three ways to create a pattern in LOLC: a) single-element patterns can be defined using sound files; b) rhythmic repetitions of sounds are created through an event-definition syntax; and c) transformation operations modify and/or combine existing patterns.

Pre-recorded sound files serve as the base musical element in LOLC. Although any sound file can be used, short and percussive sounds tend to work best. Sounds are loaded as follows:

```
mySound : "sound.aif"
```

Another way to create a pattern is to specify the rhythmic repetition of an existing pattern through bracket syntax. For example, the following pattern definition plays mySound as two eighth notes at fortissimo, a quarter-note rest, one quarter note at mezzo-forte and four sixteenth notes at pianissimo:

```
myPattern : mySound[e.ff, e.ff,
q.n, q, s.pp, s.pp, s.pp, s.pp]
```

If dynamics are omitted, mezzo-forte is assigned to the note. For a complete list of available durations and dynamics, see [8].

Patterns can also be nested. In the following example,

```
myPattern is played twice:
myNested : myPattern[w,h]
```

Each time the pattern is played, its note durations are stretched or compressed to match the target duration. In this example, the patterns remain unchanged for the whole note iteration and are halved for the half-note iteration.

Like Vocables [14], LOLC defines musical patterns as an ordered collection of items, but LOLC requires musicians to explicitly define rhythmic values, and it emphasizes rhythmic patterns that repeat single sounds. ixi lang [12] similarly emphasizes repetitions of single sounds and explicitly defined rhythms, but its grid-based approach to rhythm is both simpler and more constrained than LOLC's.

The last but most important way to create a new pattern is to transform or combine existing patterns. For all operations supported, see [8]. These operations were chosen because of their importance in studies on improvisational interaction [9] and musical pattern manipulations [19]. The syntax for all transformations follows this example:

```
pattern1 : sound1[w,h,h]
pattern2 : sound2[q,q,q,q]
myConcat:cat(pattern1, pattern2)
myTrunc : trunc(pattern2, 2)
```

The operation cat places two patterns in succession, so myConcat combines patterns based on two different audio-file sources. The operation trunc removes the final n items from a pattern, so myTrunc removes the final two quarter notes from pattern2.

3.3. Scheduling

Patterns are not played immediately upon creation. Instead, musicians must use an LOLC scheduling expression to determine when and how they play. Typically, patterns are scheduled for playback at the next beat or measure:

```
play myPattern @nextBeat
play myPattern @nextMeasure
```

LOLC supports additional scheduling methods: preview will preview the pattern over headphones and loop will play it repeatedly:

```
loop myPattern @nextMeasure ~16
```

This example loops the pattern sixteen times. Scheduling commands are shared with other clients via the text chat interface (Figure 1), but they are played solely on the local client machine.

3.4. Graphical User Interface

In LOLC's client software, commands are typed into an instant-messaging-style interface that shows both commands and chat messages from everyone in the ensemble (Figure 1). As musical patterns are created,

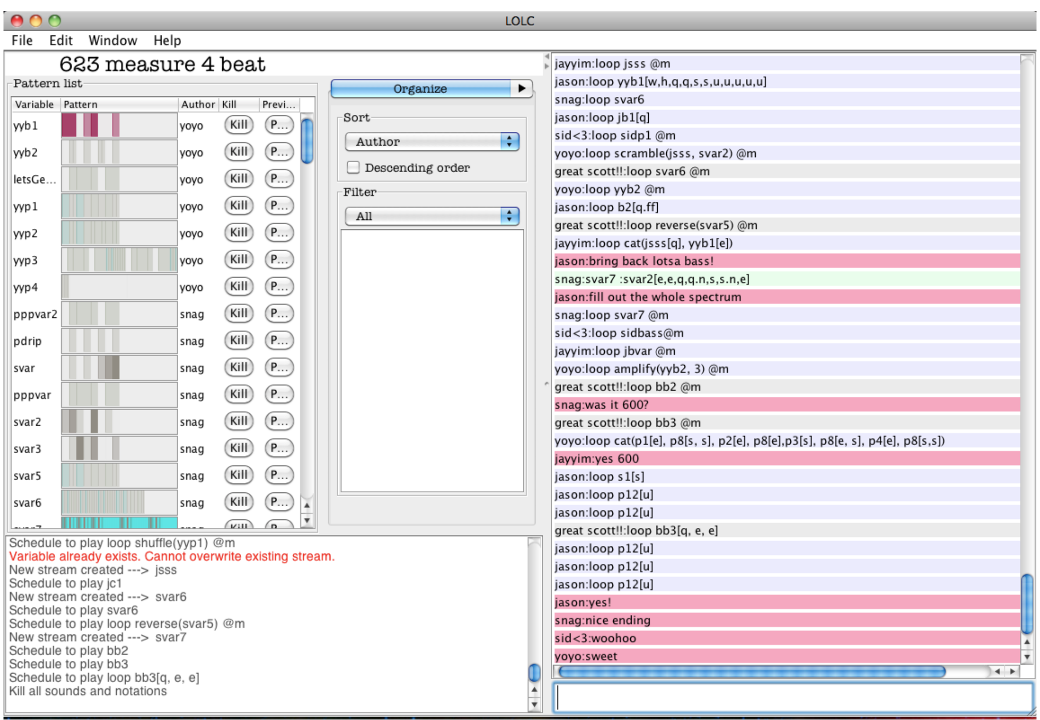

Figure 1 Screenshot of the LOLC client

they are automatically shared with the other musicians and displayed in a pattern library. Patterns are immutable once they are created so that they remain static as musicians build upon them, mimicking the collaboration of improvising acoustic musicians more than the dynamic, unpredictable shared objects of some laptop live coding environments. An info panel shows error messages in parsing and execution.

The pattern library panel on the left provides a visual interface for exploring ensemble activity, with the goal of facilitating closer collaboration and more pattern sharing among musicians. Patterns are displayed in the panel as a series of bars when they are created, along with a visualization of their content: the width of each bar corresponds to the duration of a sound, the height of a bar maps to the spectral centroid of a sound relative to the other sounds in the pattern, and the color of a bar is based on both the spectral and dynamic content of a sound. Variables are highlighted when they are played. Musicians can also sort and filter the list to isolate patterns that are created by certain musicians, created or scheduled at certain points in the performance, or based on particular audio file sources.

The LOLC server software includes a fullscreen visualization for projection to the audience. In the lower half of the screen, its visualization (Figure 2) shows all code and chat messages in a stylized, large-print format. In the upper half, each musician is visualized as a circle. The arcs between the circles represent the level of collaboration between the corresponding musicians. Chat messages are drawn in text balloons next to each circle. While a pattern is played, its rhythmic and spectral content is visualized as a series of concentric circles drawn outwards from the central circle.

4. EVALUATION AND DISCUSSION

To date, LOLC has been used in six musical performances. The musicians in most of these performances were graduate students in music technology, and some of them were also involved in the creation of LOLC. All were proficient programmers and computer musicians and many were experienced in live coding.

In April 2010, LOLC was used in a performance by the Princeton Laptop Orchestra (PLOrK); this performance is evaluated in detail in [8]. The undergraduate students who participated in this performance had more limited backgrounds in programming and computer music (and indeed, in music as well). But they still did not represent our ideal target group: highly-skilled musicians with little or no experience in programming.

This section, then, focuses on a single performance with LOLC in January 2011, in which musicians from a professional contemporary music ensemble performed with LOLC. These top-tier classical musicians have played with major symphony orchestras and also have considerable background with improvisation in experimental and/or jazz mediums. The laptop ensemble for this performance was

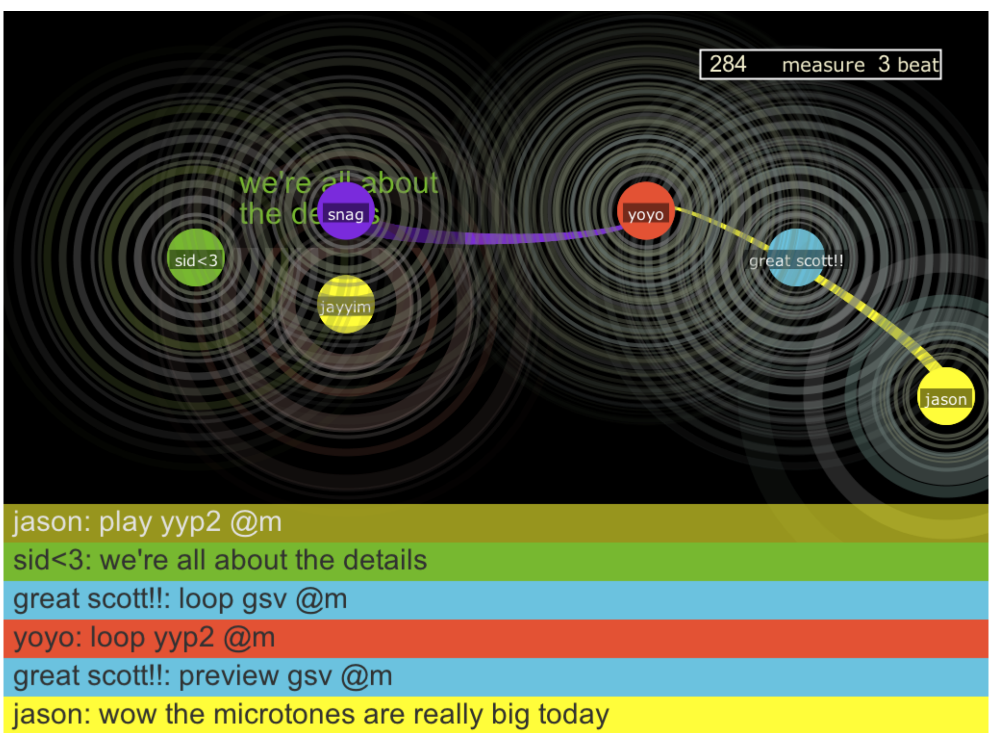

Figure 2 Screenshot of LOLC Server

composed of five members of the ensemble and one of the authors of this paper. Except for the author, the musicians had no prior experience with LOLC, no (or negligible) background in computer programming, and little or no experience with using computer music software.

One month before the show, the musicians started to learn LOLC through hour-long, one-on-one introductory sessions led by the authors. Each musician then practiced individually by following tutorial files and trying out LOLC on his or her personal computer. The ensemble rehearsed together for a total of 12 hours in preparation for the public performance. During the rehearsal process, we never instructed the ensemble about how to collaborate or how to structure the performance. We provided technical assistance and guidance on the environment, but let the ensemble develop their own structure for the improvisation and decide how to build the piece collaboratively.

Within this context, we used a variety of techniques to assess the degree to which LOLC succeeded in facilitating collaborative improvisation among the musicians. We logged code and chat messages to disk and analyzed each log quantitatively. Following the concert, we conducted an hour-long interview with each ensemble member to discuss his or her process of learning LOLC and experience of performing with it. The interviews particularly focused on how the musicians created music collaboratively. We also considered the musical output of the actual performance as well as of rehearsals.

Throughout the following evaluation, we exclude quantitative and qualitative data from the one member of the ensemble who is also an author of this paper and a developer of LOLC.

4.1. Collaborative Improvisation

Since LOLC's primary goal is to facilitate collaborative improvisation within a laptop ensemble, our evaluation focused on how successfully it did so. Since LOLC facilitates collaboration by encouraging musicians to borrow, re-use, and transform musical patterns from each other, one metric of collaboration is the degree to which patterns were shared among musicians.

In our analysis of the group's rehearsals and performance, we found a healthy level of collaboration among all musicians. During the dress rehearsal, for instance, the musicians created a total of 61 musical patterns; 19 of those patterns (31%) were based on patterns borrowed from others. The musicians scheduled a total of 117 different variables for playback; 37 of these patterns (32%) were borrowed from another musician. Although these statistics do not necessarily correlate to the quality of collaboration, they indicate a critical degree of sharing that is prerequisite to effective collaboration in LOLC, and they demonstrate that musicians were responding to each other through the music they improvised.

The amount and kind of sharing varied widely among the musicians. Figure 3 shows the number of patterns that were created and scheduled for each musician as a composite of borrowed (dark gray) and self-created ("owned") (light gray). Musicians A and E frequently borrowed patterns from other musicians (Figure 3a) but always transformed them before playing them; they never played a pattern directly borrowed from someone else (Figure 3b). In contrast, musician D never transformed a pattern created by another musician but often played others' patterns directly. Musicians B and C took a more balanced approach.

a)

b)

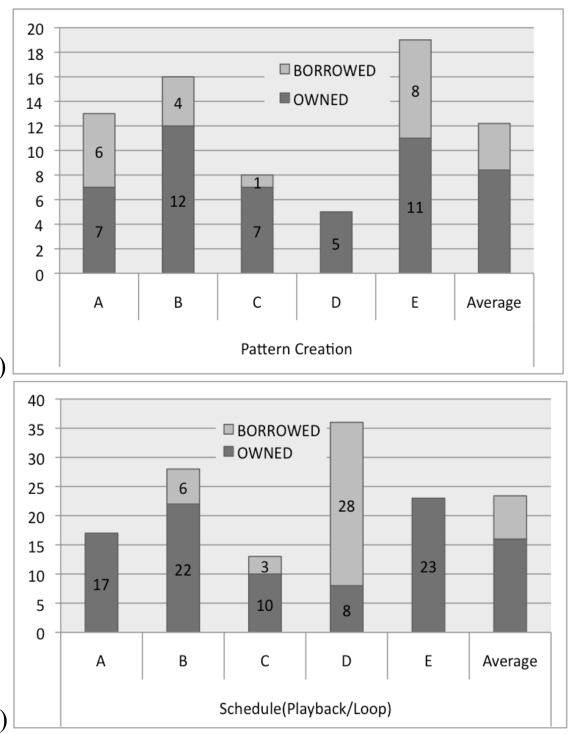

Figure 3 Number of patterns a) created and b) scheduled by each musician.

Considering this data in the context of musical improvisation, musicians A and E, who mainly created and transformed patterns, are those who introduce and develop musical ideas, while musician D listens to the patterns of others, picks them up, and responds to what others have played.

Even though different musicians have clearly adopted different roles within the ensemble improvisation, they did not determine or discuss these in advance. In interviews, we asked each musician

about their role within the ensemble. Each musician stated that there were no defined roles, though one musician noted that people did have their own signature "moves" (i.e. sound patterns) rather than roles. Also, most of the musicians noted their own particular techniques for transforming the material borrowed from others. But no one spoke of the ways in which each musician borrowed and transformed, which seems to have arisen more organically.

We also asked the musicians to describe the key ways in which they collaborated with the other musicians. The most common answer was to listen to what other musicians played and to transform or combine others' patterns. No musicians took advantage of all of the transformative operations available within LOLC; each relied on a handful of favorite operations (which varied from musician to musician).

Borrowing and transforming often became a chained process for the ensemble as musicians borrowed patterns that were themselves borrowed. One pattern from the dress rehearsal was based on eleven prior patterns (seven created from scratch) created by five different musicians in the ensemble over the course of nearly fifteen minutes. Figure 4 shows the chain of relationships among all of the variables as they were created, shared, and transformed over time. Table 1 shows the pattern definitions corresponding to each stage in the process. To us, LOLC's ability to facilitate the integration of ideas from so many musicians over such a long time scale attests to its potential to facilitate collaborative improvisation in an ensemble, using its ability to preserve the history of creation and collaboration within the performance to enhance the ability of musicians to borrow, transform, combine, and recall musical material.

Among the elements of LOLC, chat messages were the most effective in facilitating collaboration. One musician described how text chatting was used to structure the piece and to keep everyone thinking together (as opposed to each musician working in isolation). The group's only advance planning as to structure was the broad idea of a sparse beginning and gradual buildup to a sudden ending. All other details, such as timbre, density, and pacing, were coordinated on the fly through the chat window as musicians posted messages such as "sounds like we are winding down, let's go to all bass" and "ease off a bit or keep goin?" One interviewee also noted that the text chatting helped him focus on listening more and to ease the confusion coming from the unfamiliarity of his new instrument, the laptop.

The projection shown to the audience, which visualized the collaboration among musicians as lines connecting them together, also encouraged and supported improvisation. During the interviews, two musicians mentioned the visualization as a way of helping them determine with whom they had not yet interacted and from whom they wished to borrow in the future.

The musicians were proud of their ability to collaborate together musically in performance, and about the progress they made in this regard over the course of their rehearsals. In an interview, one said: "I remember the first rehearsal and I certainly was creating in a vacuum and the five other people were so as well. People were throwing out interesting things that they had come up with. As it went on, I was happy to get to the point where I was actually understanding, was able to listen, figure out what's going on and was able to do with my ears as well as eyes."

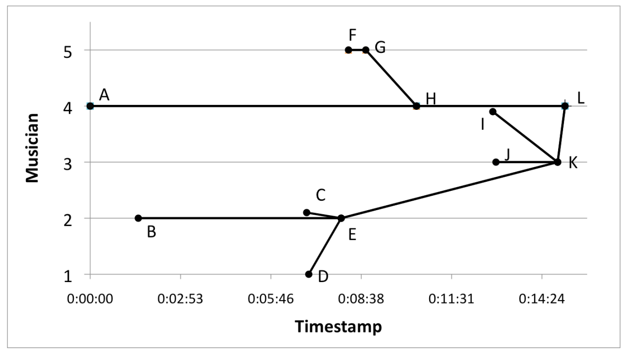

Figure 4 The chain in creating the pattern "tls7"

	Expression
A	jam : cat(b3[e,e,h.n,q.n,e,e,q.n],p43[e.n,e,s.n,s,e.n])
B	sangre:b4[e,e,e,e.n,q,q,s,s,s.n]
C	sangre1:h1[u,u,u,h.n,e,e,h.n]
D	snark: s1[e.fff,e.fff,s,s,w.n]
E	sangre2:cat(snark, sangre1, sangre)
F	hades:cat(b2[s.p,s.p,s.mp,s.mp,s.mf,s.mf,s.f,s.f],b5[h.ff,q.n])
G	newhades:mirror(hades)
H	jam6: cat(jam,newhades)
I	tls1 : cat(b1[e],p40[s,s],b1[e])
J	stutter2 : s2[u,u,u,u,u,u,u,u, w.n, h.n]
K	big1 : shuffle(cat(sangre, sangre2, tls1, stutter2))
L	tls7 : cat(big1,jam6)

Table 1 Pattern creation expression at each point in Figure 4.

4.2.Comparison to Instrumental Improvisation

Since the musicians in this performance all had extensive experience improvising on traditional acoustic instruments in jazz and/or avant-garde settings, we wanted to understand how the experience of improvising with LOLC on a laptop differed from

the more traditional modes of improvisation that inspired LOLC.

In the interviews, the biggest difference noted by the musicians was the inherent latency of interaction. One musician described the difference as follows:

> *I would always have a minute delay from the time I figure out what I want to do until I actually could get the computer to play what I wanted to do.*

Part of this stems from typing, but there is a more fundamental difference here in how sounds are generated in each context. One musician noted that with a conventional instrument, playing is second nature and becomes a natural extension of musical ideas, while in LOLC it takes time to write a script to play what is intended. There is also a step of translating musical ideas into a symbolic, notated form, as one musician noted:

> *I got pretty good at what the rhythm is, for example, e stands for eighth notes, and how to translate that language notation-wise.*

Not only must a player translate the music in his mind to the corresponding syntax, but he also must think about the music in terms of traditional parameters of musical notation that correspond to its symbolic representation in LOLC. In contrast, improvisation with traditional instruments tends to require less notation-based thinking and more listening to sounds and responding immediately with motor memory [17]. We expect some of the sub-tasks, like making rhythmic patterns, could become more automatic with enough practice, but still will not approach the level of perceptual motor skills [16].

The inherent delay in textual environments like LOLC can be a serious drawback to facilitating responsive collaborative improvisation, especially in the conversational style of jazz improvisation. However, other aspects of LOLC differ from instrumental improvisation and offer unique advantages. One member pointed out that LOLC is fundamentally different because in LOLC you schedule something as many times as you want, let it go and you are free to do something else while it is being played. In other words, LOLC permits a single player to instantiate many simultaneous, independent layers because each can continue automatically once it is scheduled. In contrast, when a musician improvises with a conventional instrument, he or she must constantly be engaged in the production of each individual event. LOLC, like many laptop music environments, enables musicians to automate the management of these low-level musical events and focus on higher-level decisions [6].

Another musician pointed out that in LOLC, you could literally pick or steal fragments from other people and reproduce them identically and promptly. In contrast, in the instrumental context, a player has to listen to the material and try to reproduce it.

The musicians also commented on the nature of the transformation operations supported by LOLC. Many of these operations involve a degree of randomness. One musician had trouble imagining how the transformed pattern would sound; this was ultimately not a problem but a benefit: it led the musician to improvise with a novel mindset. Instrumental musicians often believe that unpredictability comes from a lack of musical or technical proficiency. But in LOLC, they transition into an environment where the one-to-one mapping of a traditional instrument is sometimes replaced by a one-to-many mapping in which a gesture can trigger a complex set of events, much as in many computer music interfaces [10]. The musicians in this performance made this transition successfully, adapting to one-to-many and sometimes non-deterministic ways of creating material.

We have previously noted that musicians tend to use LOLC to create loop-based music with slowly evolving musical textures [8]. It appears that the inherent differences of LOLC from traditional instrumental improvisation contexts push musicians to play this particular style of music.

On the other hand, some interviewees pointed out that both types of improvisation have much in common. One musician said:

> *To me it was a similar feeling of what it feels like if I was performing a piece of music on a normal instrument. I am trying to make something special in the moment for that performance. To me, it still has the same basic musicianship issue, trying to be listening to others, to be responsive to what's going on around you, and not just to focus on yourself. To me it was more of trying to take your normal experience of making music and applied it to this program rather than having the program somehow change the way I make music.*

All musicians stated that they enjoyed the improvisation with LOLC as they do with conventional instruments.

5. CONCLUSION AND FUTURE WORKS

In conclusion, LOLC has largely succeeded in facilitating collaborative improvisation among a target group of musicians with little background in computer music and programming. In addition, although the musicians found that LOLC is fundamentally different from improvisation with conventional instruments, they made successful transitions.

This year, we have also focused on a new area of exploration with the LOLC environment. We extended LOLC to the realm of real-time notation, in which musicians sight-read conventional or graphical notation live, in performance, as it is rendered on a

digital display [7]. In this scenario, LOLC musicians can manipulate musical score fragments in addition to audio files, and those fragments are displayed in real time to sight-reading musicians (on traditional instruments) with whom each laptop musician is paired. Given the unique benefits of text-based laptop improvisation with LOLC and performance on traditional instruments, we find the integration of both modes within a single performance environment to be particularly exciting. In February 2012 we presented an initial performance using LOLC for real-time notation, and a comprehensive study of the system is currently underway.

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7. REFERENCES

[1] Allen, S. Teaching Large Ensemble Music Improvisation. *Radical Pedagogy* 4(1). Available at radicalpedagogy.icaap.org/content/issue4_1/ 01_Allen.html. 2002.

[2] Berliner, P. Thinking in Jazz: The Infinite Art of Improvisation. Chicago: *University Of Chicago Press*. 1994.

[3] Brown, A., and A. Sorensen. Interacting with Generative Music through Live Coding. *Contemporary Music Review 28*,1(2009), 17–29.

[4] Brown, C., and J. Bischoff. Indigenous to the Net: Early Network Music Bands in the San Francisco Bay Area. Available at crossfade.walkerart.org/ brownbischoff, 2002.

[5] Collins, N., et al. Live Coding in Laptop Performance. *Organised Sound 8*,3(2003), 321–330.

[6] Collins, N. Generative Music and Laptop Performance. *Contemporary Music Review* 22, 4 (2003), 67-79.

[7] Freeman, J. Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-time Music Notation in Live Performance. *Computer Music Journal 32*, 3 (2008), 25–41.

[8] Freeman, J. and Troyer A.V. Collaborative Textual Improvisation in a Laptop Ensemble. Computer Music Journal 35, 2(2011), 8-21.

[9] Hodson, R. Interaction, Improvisation, and Interplay in Jazz. Routledge, New York, 2007.

[10] Keislar, D. A Historical View of Computer Music Technology. In R. Dean (ed.), *The Oxford Handbook of Computer Music*. New York: Oxford University Press, 2009, 11–43.

[11] Lewis, G. *Virtual Concerto*. Unpublished musical score. 2004.

[12] Magnusson, T. The ixiQuarks: Merging Code and GUI in One Creative Space. *In Proceedings of the International Computer Music Conference* 2 (2007), 332–339.

[13] McCartney, J. Rethinking the Computer Music Language: SuperCollider. *Computer Music Journal* 26, 4 (2002), 61–68.

[14] McLean, A., and G. Wiggins. Words, Movement and Timbre. In *Proceedings of the 9th International Conference of New Interfaces for Musical Expression,* 2009.

[15] Monson, I. Saying Something: Jazz Improvisation and Interaction. Chicago: *University of Chicago Press*. 1996.

[16] Nilson, C. Live Coding Practice. In *Proceedings of the 7th International Conference on New Interfaces for Musical Expression*, 2007.112–117.

[17] Pressing, J. Improvisation methods and models. In Sloboda, J.A. (ed.), *Generative Processes in Music: Psychology of Performance Improvisation and Composition*. Oxford: Clarendon Press. 1988. 129–178.

[18] Rohrhuber, J. Networked Programming. Available on-line at supercollider.svn.sourcefo-rge.net/viewvc/supercollider/trunk/common/build/Help/Libraries/JITLib/tutorials/jitlib_networking.html?revision=10439.

[19] Spiegel, L. Manipulations of Musical Patterns. *In Proceedings of the Symposium on Small Computers Q7 and the Arts*, 1981. 19–22.

[20] Wang, G., and P. Cook. ChucK: a concurrent, on-the- fly audio programming language. In *Proceedings of the International Computer Music Conference,* 2003. 219–226.

[21] Wang, G., et al. CoAudicle: A Collaborative Audio Programming Space. In *Proceedings of the International Computer Music Conference*, 2003. 331– 334.

[22] Zorn, J. John Zorn's Cobra: Live at the Knitting Factory. New York: Knitting Factory Works KFW124, compact disc. 1995

ISSUES IN INSTRUMENTAL DESIGN: THE ONTOLOGICAL PROBLEM (OPPORTUNITY?) OF 'LIVENESS' FOR A LAPTOP ENSEMBLE

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ABSTRACT

Through the recent work of MMUle[1], this paper will explore issues in new instrumental design for 'live' performance. For MMUle, the intimacy of the interaction between human and machine is exposed through 'live' performance and this has resulted in the relationship between musician and machine being in a process of constant negotiation. Subsequently, the paper will consider some of the technical approaches and performance strategies MMUle has developed in an attempt to better interact with technology through the design of new instruments for musical performance. It will consider the relationship between the musician and the computer as musical instrument; it will consider the causal relationship between performative action and resulting sound, which has remained an issue for some spectators of music laptop performances and will explore this in light of MMUle's approach to expand the affordance of the laptop computer in relation to its musical and performative potential; and some consideration will be given to the use of interface devices such as the computer program MaxMSP, the games controllers x-box and wii, and the human body as MMUle attempt to interact with machines. The paper will discuss some of the implications and applications of developing new software instruments for performance and this will be explored through two pathways to 'liveness': performance as a constructed 'live' event and 'liveness' considered as part of a creative strategy.

1. WHO ARE WE?

MMUle was set up in 2008 within the Department of Contemporary Arts at Manchester Metropolitan University to explore issues in performance practice, composition and improvisation through laptop and other technologies within the context of interdisciplinary arts practice. The ensemble has worked closely with practitioners from a variety of traditions (dance, contemporary theatre, visual arts, music) within the wider context of contemporary art and since 2010, has developed its practice as a trio with the laptop performers and composers, Martin Blain, Nicholas Donovan and Paul J. Rogers. All three performers run Max/MSP on a MacBook Pro, control a variety of MMUle developed patches, with each performer generating sounds through an individual portable powered speaker. Subsequently, each musician performs on a self-contained 'instrument'.

2. NOTIONS OF 'LIVENESS'

2.1. Performance as a constructed 'live' event

With the introduction and development of reproduction technologies throughout the last century, notions of 'liveness' have continued to confused, excited, frustrated, and divided critical thinkers on what we may understand by the term 'liveness'. Before the development of reproduction technologies performance was experienced as it happened – there was no alternative. However, the development of analogue and more recently digital technologies has had a profound impact on the way creators make work and spectators[2] encounter the product. Back in the late 1970's consumers were asked 'Is it live or is it Memorex?'[3] For those of us too young to remember the advertising campaign, the product offered repeatable performances of live or mediatized events, time and time again at a place in time convenient for the consumer. Life (or rather 'entertainment') as we knew it was about the change for the better – or so they proposed. Of course, the medium the product was being advertised through – television – in those days had inferior quality audio systems and was not able to demonstrate the full potential of the new technology. I particularly remember the poor audio re-production quality of the 'mono' speaker enclosed in the television I had access to at that time. However, what was presented through a variety of mediatized technologies at the time as being 'live' was pretty much re-

[1] It is the author's intention to make all works discussed in this paper available as audio and/or video files. Please email the author for full details of the web link to MMUle files.

[2] My use of the term 'spectator' is taken from Stanton B. Garner's, Jr [11] use of the term representing an individual participant within an audience.

[3] See http://www.youtube.com/watch?v=Bkt8Dwzl6Sg [16]

created as near to the conditions of the 'original', at least at the level of audio and/or visual duplication, through the new magnetic tape technology. The counter-claim, from the Musicians' Union was to 'Keep Music Live'[4]. However, the introduction of re-production technologies into the market place, had, for some critical thinkers, called into question the status of 'live' performance. During the 1990's these contradictory positions on 'liveness' were reflected in the writings of Philip Auslander and Peggy Phelan.

2.1.1. The Auslander/Phelan position

In response to this new order, Auslander argues that the cultural economy has created a 'competitive opposition' between the live and the mediatized and suggests that modern audiences have become desensitized to its effect. However, he suggest that this opposition is not derived 'from the intrinsic characteristics of live and mediatized forms but, rather, as determined by cultural and historical contingencies'. [1,11] From this position he goes onto reject the argument for there being ontological differences between the 'live' and the 'mediatized'; for Auslander, the construction of 'liveness' appears to be determined by historical rather than ontological conditions.

Peggy Phelan, offers a contradictory view of 'liveness'. For her:

> Performance's life is in the present. Performance cannot be saved, recorded, documented, or otherwise participate in the circulation of representations of representations: once it does so, it becomes something other than performance. [18,146]

Here, Phelan, connotes that, for her, there is a causal relationship between performance and presence and that presence exists in the performance space to be experienced by those present in the space at a particular moment in time determined by the performers. Subsequently, for her, the degree to which 'performance (and I take this to mean 'liveness') attempts to enter the economy of reproduction it betrays and lessens the promise of its own ontology'. (18:146) For Phelan, there is 'value' and 'celebration' in the 'impossibility of seizing/seeing the real anywhere anytime.' (18:192)

For the laptop musician developing work within an interdisciplinary context for 'live' performance through the sonic manipulation of 'live' and 'mediatized' materials there is much fertile ground to explore here. Viewed from the horizon of the laptop these positions appear contradictory not complementary.

2.1.2. Disrupting the real - Dreaming Of Giotto

My work *Dreaming Of Giotto* for Piano and Laptop (piano samples) was devised to be performed in an art gallery to accompany the paintings of Val Kosh. One of the conceptual ideas for this piece was to explore notions of 'liveness' through the juxtaposition and manipulation of sounds recorded in different acoustic spaces – highlighting the space between the real and the virtual. A set of piano fragments was composed, conventionally notated, performed by the pianist Philip Thomas and recorded in the studio[5]; in response to each fragment, I recorded a set of improvised piano responses in the form of small motivic gestures/fragments, recorded at a different location on a different piano. The performance strategy used in the realization of the work combined three levels of activity: machine instillation/performance; laptop performance; pianist/improviser. Whilst the machine instillation/performance activity underpinned the duration of the exhibition, the installation/performance activity was 'disrupted' by interventions of between 20-45 minute performances from either or both the laptop performer and/or the pianist. The machine instillation was controlled by a Max/MSP patch that juxtaposed and manipulated the pre-recorded piano samples – there were also moments of silence built into the programming to heighten the ritual of performance activity when sound did occur. The laptop performer developed compositional/improvisatory strategies to combine and manipulate the pre-recorded piano samples as appropriate to the requirements of the performance space and in response to the perceived energy being generated by the spectators encountering the work at different times throughout the day. In addition, when performing with the pianist the laptop performer would take a 'live' feed from the piano adding an additional layer to the musical texture.

Whilst the three levels of activity were performed 'live' in the space, it is difficult to see how this particular performance strategy could locate itself within the critical positions suggested by Auslander and Phelan. It has what Phelan would identify as 'presence' represented in the devising/improvising/performing work of the laptop performer and pianist working in real-time. Similarly, my attempt to draw attention to the medium of recording as a compositional device and performance strategy as well as through the mediatization of both an acoustic instrument and the properties of an acoustic space would not fit well with the central concerns of Auslander's position.

The notion of 'disrupting' established practices and navigating a trajectory between the 'live' and the 'mediatized' is considered in the work of Susan Broadhurst. Writing about and considering how new performance practices have begun to emerge in some arts disciplines, she suggests that 'tensions exist within the

[4] Keep Music Live was first used as a slogan in 1965. See http://www.musiciansunion.org.uk/ [14]

[5] My thanks go to Dr Jason Woolley at MMU for his expertise and time in the recording of both sets of samples for this work.

spaces created by [the] interface of body and technology' [3:1] and has defined these spaces as 'liminal'. They exist for Broadhurst on the 'threshold' of the physical and virtual worlds – this can refer to the connection between performer and machine as well as the connection between performance and spectator. Broadhurst suggests that 'it is within these tension-filled spaces that opportunities arise for new experimental forms and practices. [3,1]

2.1.3. Performer and Machine; Performance and Spectator

To consider the opportunities Broadhurst suggests may arise when attempting to 'disrupt' established modes of thinking and practices, it may be useful to consider how musical performance is working in more conventional spaces within more established traditions and then to consider how this might apply within MMUle's developing practice.

On 2nd July 2009, *Steve Reich* and *Kraftwerk* appeared 'live' at the Manchester Velodrome in a double header as part of the Manchester International Festival. Steve Reich composed a new work *2x5* for the American New Music Ensemble *Bang On A Can* and *Kraftwerk* performed works from their back catalogue. In relation to our discussion on 'liveness', my experience of the two performances, was significantly different. Luke Bainbridge, from the *Observer* Newspaper appears to have had a similar experience of the event:

> Whereas the Velodrome seemed to hamper Reich's *2x5*, with the cycle track distancing the audience from the band like an athletics track can do at some football stadiums, for Kraftwerk it suddenly, inevitable, makes perfect sense. [2]

For *Kraftwerk,* having the GB cycling team wiz around the track during part of the performance only added to the occasion. The issue for me was simple: *Kraftwerk* worked at establishing a 'presence' in the space: *Bang* On A *Can*, at this venue and with this particular audience did not.

Cormac Power, suggests that '[t]heater and presence…are so connected as to seem almost synonymous.', [19,1] and considers 'presence' to be manifest through a variety of constructed approaches. For Power, 'presence' can be located not only in the relationship between the physical performers and the spectators, but can also be afforded to inanimate objects present in the performance area. Power's identification of the use of technological 'presence' as one example of inviting the spectator to experience the event as 'live' may also begin to explain how the individual members of *Kraftwerk* were able to maintain the conditions of 'liveness' during their 'absence' from the performance area for part of the evening's performance. My recollection of the event was that while *Kraftwerk* constructed a 'live' environment from the elements at their disposal (space, presence, etc,), *Bang On A Can* did not. The notion of constructing 'presence' through the juxtaposition and considered manipulation of human performers and inanimate objects present in the performance area was consider in the realization of *Dreaming Of Giotto.*

2.2. Performance codes

For MMUle, positioning an emerging laptop performance practice within the wider context of musical performance within the performing arts is problematic. Jim Cascone once said: 'Falling into neither the spectacularized presentation of pop music, nor the academic world of acousmatic music, laptop musicians inhabit a netherworld constructed from performance codes borrowed from both.' (5:6) Whilst the *Kraftwerk* and *Bang On A Can* performances contained some of the performance codes Cascone associates with popular music, at the opposite end of the performance spectrum it is useful to consider how performance practices work within the field of electroacoustic music. Simon Emmerson suggests that 'presence' in electro-acoustic performance might exist in three simultaneous and interacting states: the physical, the psychological, and the personal and social. [8] Emmerson suggests that at the 'physical' state:

> Most music now heard appears to present little evidence of *living presence.* Yet we persist in seeking it out. From grand gesture to a *noh*-like shift in the smallest aspect of a performer's demeanour, we attempt to *find releationships* between action and result. [8,xiii].

Whilst the relationship between performative action (cause) and resulting sound (effect) remains an issue for laptop performers engaging in 'live' performance, within the world of electroacoustic music performance, the issue of causality that connects seeing to hearing does not appear to receive the same level of attention. In fact, Emmerson, more recently, when discussing cause and effect directs his attention to the relationship between the 'hearing' of a cause and the 'hearing' of an effect. [9,269]

At the 'psychological' state we are encouraged to search for 'clues' as to how the sound materials are likely to develop over time throughout the work (setting up patterns of expectation that are either fulfilled or denied); and the 'personal and social' state considers the encounter's relationship with the work in performance within the context of their own belief system; here, Emmerson, suggests, for example, that 'presence' might exist in the 'meaning of the utterance' of the work or in the 'aura' generated by the performer/performance.

Within this particular tradition, notions of performantive 'presence' are realized through what Emmerson defines as 'the sounding flow';[8,30] the 'sounding flow' is prioritized over any resulting visual

stimuli that may result as a consequence of human or machine interaction taking place in the performance space at the same time. Retreating a little from this extreme position, MMUle, working within an interdisciplinary context, has chosen to locate its musical practice within the wider context of contemporary art where the audio and the visual complement one another. In support of this position, Gordon Graham suggests that:

> The proposition that music is for listening to…should not be confused with the false proposition that music is *only* for listening to. On the contrary, music is one of the *performing arts*, and most composed music has been written first and foremost for [‘live’] performance. [10,210]

2.3. On performing and not-performing

One approach I have found useful in developing constructions of ‘presence’ and considering the relationship between the Performance and the Spectator for laptop performance is through Michael Kirby’s work *On Acting and Not Acting.* [12] Kirby offers a continuum of states for acting with no values of privileges given to each condition. Kirby suggests that, ‘[t]o act means to feign, to simulate, to impersonate’. [12,43] He goes on to claim that not all performing is acting and that it is possible (in fact encouraged!) to move between states within a performance. I am not suggesting here that musicians (laptop or other) should consider their musical performance in terms of their ability to act, but a spectator, as Broadhurst has suggested, will, when presented with a body in a performance space attempt to make sense of the complexities of the work.

Kirby’s continuum for acting/not-acting contains five positions[6]: non-matrixed performing, symbolized matrix, received acting, simple acting, complex acting. Kirby suggests that whilst ‘the differences between acting and non-acting may be small…it is precisely these borderline cases that can provide insights into acting theory and the nature of art.’ [12,43] The application of Kirby’s continuum to ‘live’ laptop performance practice as a way to better understand how bodies (human – performers/spectators and inanimate objects) can work and interact in the performance space maybe a useful path to explore.

Fig.1: MMUle performing the first section of *Cut Up Slow Down.* MMUle performers from left to right: Nicholas Donovan, Paul J. Rogers, Martin Blain.

Cut Up Slow Down, is a work initiated by Paul J. Rogers and devised by MMUle. The work’s improvisatory structure take c.15 minutes to complete and is divided into three independent sections with each section exploring a specific performance strategy. In the first section two performers use body movement to initiate and control pre-recorded samples. Hand gestures (the causal agent) are presented to the computer’s in-built video camera and the resulting ‘effect’ is controlled by a bespoke Max/MSP patch. As a counterpoint to this activity, a third performer develops a simple but continually changing ostinato pattern by performing precise movements on a wii controller that generates material through a bespoke Max/MSP patch; Fig.1, shows a visual representation of this section in performance. In the second section, all performers use a games controller to generate and manipulate the ‘sounding flow’ through a different bespoke Max/MSP patch which is further exploited in the final section where each laptop performer, at a pre-determine time, stops performing on their laptop computer and moves towards the microphone to become a sound generating agent for the other two laptop performers to ‘capture’ the ‘live’ sound for processing as determined by the demands of the ‘sounding flow’. In past performances, sounds generated for ‘live’ capture have included a variety of small percussion instruments, vocal sounds, a broken zither (as seen in fig.1) and toy instruments.

MMUle’s approach to developing and constructing ‘presence’ in this work has been through a process of play and experimentation. Allowing each performer to choreograph (but not fix) specific performative actions through a process of collective and collaborative interaction with the sound materials at play, has enabled a personal and spatial relationship to develop between the musicians in the performance space and this has facilitated and encouraged a ‘meaningful response’ to develop between the performers and spectators. Whilst the

[6] See Kirby [12] for a full explanation of each state along the continuum.

development of a Kirby-led performative continuum is ongoing, the development of this approach has begun to address the wider performative issues concerned with laptop performance. The physicality of the performer through movement and gesture gives a sense of purpose to the performance, and there are enough ‘clues’ offered by each performer to regain a hint of connection between the visual and audio streams for the spectator to be convinced that what they are experiencing is taking place ‘live’ in the performance space. I should add that this approach is not intended to undermine the ‘aural performativity’ of laptop performance as identified by Caleb Stuart, but is intended to encourage and facilitate for the spectator, a ‘shift in understanding…from a visual focus to that of aural performativity.’ [20,60] This approach and level of engagement can be negotiated appropriately.

The Kirby model has been useful for MMUle not only in attempting to better understand how notions of ‘presence’ can help to build relationships with spectators, but it can also begin to address some of the key issues that have challenged the spectator when attempting to engage with laptop performances[7]. Through MMUle’s adaption of Kirby’s paradigm, the apparent loss of connection between performative gesture and resulting sound has to some extent, been regained; the level of technical and musical interpretive skill needed to perform on the instrument (machine) has been made evident, not only in the ‘sounding flow’ of the composition but also through medium of the ‘visual’ performance; and the apparent distrust from spectators regarding the relationship between performer and machine in relation to laptop performance is being resolved as spectators are provided with more ‘clues’.

In *Cut Up Slow Down,* the relationship between each performer and machine as presented to the spectator has been carefully considered. For me, there is a ‘presence’ established between the performers and their machines and this ‘presence’ is offered to a spectator as being ‘live’. This notion of considering the relationship between mediated forms and their impact on spectators has been further explored in the work of Freda Chapple and Chiel Kattenbelt, within the contextual framework of intermediality.

Freda Chapple and Chiel Kattenbelt suggest that ‘intermediality is a dominant trend in the arts and media’ (6,11). They continue:

> We locate intermediality at the meeting point in-between the performers, the observers and the confluence of media involved in a performance at a particular moment in time. The intermedial inhabits a space in-between the different realities that the performance creates…[intermediality] operates in-between performer and audience; in-between theatre, performance and other media; and in-between realities – with theatre providing a stage for the performance of intermediality. (6,12).

2.3.1. The Stranger – an intermedial Opera

The intermedial approach informs MMUle’s current project: *The Stranger – a Laptop Opera*. MMUle is collaborating with the experimental theatre company *proto-type theatre,* a video artist and a lighting designer on the development of a music theatre work. The work takes the novel, *The Stranger* by Albert Camus as its starting point and through a process of experimentation is beginning to discover ways to juxtapose, and interact with a variety of media. Each member of MMUle is sonically attached to a designated actor/vocalist. At a basic level the vocal sounds produced by an actor/vocalist are captured by a laptop performer and used as source material for improvised sonic structures. However, at a more profound level the relationship between the laptop performers and actor/vocalists is encouraged to develop as they begin to explore the creative opportunities the technologies afford.

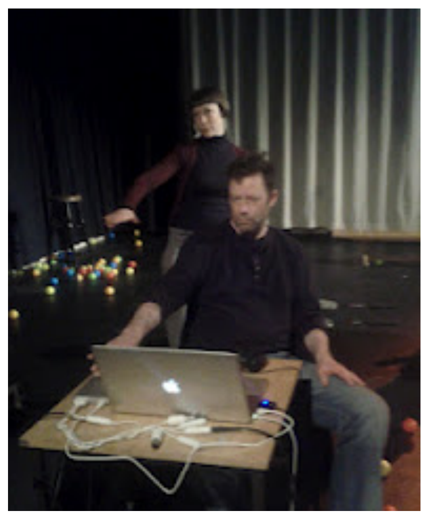

Fig.2: Paul and Gillian rehearsing a section from *The Stranger.*

Fig.2, shows Paul J. Rogers and Gillian Lees working in the early stages of the process. Here, they are exploring the relationship between the sounds and movements they are creating: this improvisation begins with Paul capturing the vocal sounds Gillian is producing and Gillian is copying the physical movements Paul is making as he interacts with his computer to control and manipulate the captured audio. At moments during this particular session it became evident that both Paul and Gillian where working in, or trying to find sub-consciously, that space Broadhurst has defined as ‘liminal’. For moments in this

[7] For a further discussion of some of these issues see Stuart [20], Morris [13] and Cascone [4].

improvisation Paul and Gillian reported that it was not apparent who was initiating material and who was reacting to the process.

The process of identifying and documenting 'insights' in this work is explored in this project through a practice-as-research[8] (PaR) methodology. PaR is a methodology used by practitioner-researchers to undertake a piece of research where practice remains a substantial element of the research inquiry. Whilst the PaR initiative, in England, is more established as a research dissemination tool in most other arts practices, this methodology has attracted little attention within the wider music research community. One method developed within this PaR inquiry has been for all practitioners (from different arts disciplines) to share in the process of critically reflecting on their participation in the creative process. As Robin Nelson suggests, this way of developing work, within the context of a PaR inquiry exploits the notion of 'play' as a 'method of inquiry, aiming not to establish findings by way of data to support a demonstrable finite answer to a research question, but to put in play elements in a *bricolage* which affords insights through deliberate and careful juxtaposition.' [15,109]

One of the performance strategies used in the development of this interdisciplinary approach to the making of work has been to facilitate periods of personal and critical reflection during the making of the work and this has encourage all practitioners to search for and discover the 'liminal' meeting points Broadhurst, Kirby, Chapple and Kattenbelt have identified and have encouraged practitioners to explore.

In the opening section of *The Stranger,* I have initiated material for further development: vocal sounds (sung harmonic textures, whispered speech, extended vocal techniques) combine with acousmatic sounds that are suggested within the text of the novel (footsteps, parakeets, breathing, buzzing hornets, etc.). Through a process of 'play' this initial material is being presented and manipulated in a variety of ways and encouraged to collide with the creative processes being explored within the disciplines of the other collaborators and this is leading to the development of new 'insights' within MMUle's developing practice.

The interplay of 'live' and 'mediated' forms in laptop performance has generated new formal structures for musicians to consider. Steve Dixon and Barry Smith are, 'unequivocal that the conjunction of performance and new media has and does bring about genuinely new stylistic and aesthetic modes, and unique and unprecedented performance experiences, genres and ontologies.'(7:5)

[8] In 2001, the University of Bristol ran a five-year AHRB funded project: Practice as Research in Performance (PARIP) to 'investigate creative-academic issues raised by practice as research.' (http://www.bris.ac.uk/parip/introduction.htm) (accessed 20/1/12). [17]

2.3.2. At the end of this pathway

We began our discussion on 'liveness' as a constructed 'live' event from the binary opposition perspectives of Auslander and Phelan. Viewed from their specific location 'liveness' appeared to be reductive and divisive – Auslander and Phelan may now appear far away. Given the more recent thinking around notations of 'liveness' and in particular the ideas that 'liveness' may not just be linked to what we have come to understand as those constructs of time and space but may also be considered in dialogues with other 'realities', - there is a suggestion here that the locus of 'liveness' may have shifted from the position of time, space and location to the cognitive space of the spectator. I am excited by the fact that this may now be an opportunity particularly for those who wish to accept it to regain conscieness from the desensitised would of 'liveness' Auslander would let us believe we have existed in.

2.4. 'Liveness' - a creative strategy

For the second part of my journey into the complex world of working with notions of 'liveness', I would like to navigate a pathway that considers the potential of exploiting both 'live' and 'mediatized' audio forms as part of a compositional strategy. As we have seen from the recent work of MMUle, digital recording technologies have made it possible to record, perceive and manipulate the subtle differences of 'live' and 'mediatized' forms. In *Dreaming Of Giotto* for example, the subtle differences in spatial properties imbedded in the recordings of both pre-recorded pianos is made evidenced when heard in juxtaposition; the spatial 'presence' in the recordings are further heightened when combined with the sound of a 'live' pianist performing in the performance space.

Navigating a compositional trajectory between the 'live' and the 'mediatized' is problemetic: at best, there is much to see and explore; at worst, the terrain may appear hostile and uninviting. Whilst in most cases, the acoustic properties inherent within and between 'live' and 'mediatized' forms may be relatively easy to decode for performers and spectators, it is the decoding of the subtle acoustic differences afforded to specific types of media that is potentially more difficult to decipher. However, it is within these tension-filled spaces that, for MMUle, have provided materials for compositional structures to expand and develop.

One approach I have found useful in developing this particular approach to laptop composition in performance is to plot out a few notable coordinates I have discovered along the way. My approach to 'liveness' – and by this I mean developing computer instruments for performance, has resulted in thinking about the 'live' and the 'mediatized' as points along a continuum. Within the recent work of MMUle the following 'live' and

'mediatized' materials have been used for the development of compositional structures:

Mediatized Live Digital Samples: these samples include sound sources recorded in advance of performance and can be recordings of acoustic instruments. The recordings of two pianos, each in a different special location is an example of this type of recording – within *Dreaming Of Giotto* two sets of Mediatized Live Digital Samples were used in juxtaposition with a 'live' performer in the performance space.

Second Generation Mediatized Live Capture: these samples are captured 'live' in performance and are intended to highlight the mechanical 'presence' of the medium being recorded. In a recent performance of *Cut Up Slow Down* within the final section, sound samples are captured 'live' through the medium of vinyl. The term 'second generation' is used to infer that this form of capturing will purposefully expose the identity of the 'mediatized' form. In other works, not discussed in this paper, this form of capturing has been used to expose tape-cassette hisses as well as radio interference within the compositional structure.

Live Acoustic Capture: this point on the continuum represents any sound captured 'live' in the moment of performance. This mode of capture has, for MMUle, produced some unexpected but extremely interesting results as it is not always possible to predict what will happen in the moment of performance, both within the sound source being recorded as well as the environment being captured. In *Dreaming Of Giotto,* the 'live' piano sounds were captured and processed alongside the Mediatized Live Digital Samples manipulated by the laptop performer. Within sections of *The Stranger,* vocal sounds in the form of sung text, whispered recitations and experimental vocal techniques are captured and exploited within the developing musical texture. At times, in both works, background sounds (both unpredictable and planned) were included in the audio file at the moment of capture resulting in structural implications for the future direction of the 'sounding flow'.

Acoustic Human Sound Capture: this mode of capture has been particularly useful for MMUle in the development of *The Stranger.* A radio microphone is attached to each actor/vocalist and is used to develop 'location' sounds; these may include the sounds of footsteps, percussion body sounds, sounds made with objects in the space. This approach, whilst producing a rich variety of sounds for sonic manipulation also invites the spectator to witness the cause and effect during the production of the sound. With these audio files stored for use later in the work, the spectator has been provided with the 'clues' to know how some of the materials has been produced facilitating a potential relationship pathway, between the spectator and the performers, to develop.

Live Image Capture: working within an intermedial context, the capturing of visual images for editing and playback by the video-artist during the performance of the work is providing an opportunity for the video artist, MMUle, the lighting designer and the actor/vocalists to begin to explore potential meeting points in-between the different realities that the performance and technologies suggests. This is a new point of departure for MMUle the results of which will be disseminated in a separate paper.

In *Dreaming Of Giotto, Cut Up Slow Down* and throughout the initial rehearsal process for *The Stranger,* one approach to developing a compositional strategy has been to allow materials from one or more of these categories to collide as part of the devising process. Each mode of sonic representation listed above, has generated a certain type of sonic 'presence'. My initial anaylsis of the materials would suggest that Mediatized Live Digital Samples highlight the 'spatial' dimension; Second Generation Mediatized Live Capture bring into focus the 'mechanical' representation of the medium being recorded; Live Acoustic Capture can work as a means to a 'dislocation' of time; Acoustic Human Sound Capture can highlight the 'causal' properties of the medium and Live Image Capture will give preference to the 'visual'.

Whilst, as suggested in these definitions, the distance from the 'live' to the 'mediatized' may be small and in many cases it may be difficult to classify within my conceptual framework, this approach has shed some light for me and MMUle on a compositional possibilities the introduction of digital technologies has afforded laptop performance practice. The continuum of points between the 'live' and the 'mediatized' will no doubt expand as MMUle's performance practice continues to develop and explore new pathways. For now, the continuum has proved to be a useful starting point to develop a compositional strategy. So how has this approach to sonic design impacted on the development of a digital instrument?

2.4.1. Instrumental design for 'live' performance

As Phelan suggests, there is something 'special' about live performance that is lost when reduced to a recorded form. With live performance the spectator is invited to witness those characteristics we have come to understand as performance. These characteristics may include, as I have already suggested, the ability to build a relationship with a spectator through personal and performative understandings of 'presence'; by being able to 'communicate' the meaning of a musical structure to a spectator through technical skill and musicality as demonstrated through an accomplished instrumental

technique; as well as being able to transcend a spectator through the experience of performance.

Whilst MMUle has already begun to address some of these issues through its own developing performance practice, many of these characteristics of performance that spectators have come to expect have needed to be re-negotiated in light of the new technologies available to musicians. By positioning ourselves within Kirby's matrix MMUle has begun to build a relationship with its spectators. However, it is the intimacy of the interaction between the laptop performer and 'instrument' that is of particular interest to the members of MMUle as they continue to work at developing a particular laptop 'technique' that can demonstrate technical skill in relation to musical intent.

Fig.2, is a multifunctional Max/MSP patch[9]; it is divided into eight areas of activity and attempts to address the issues of causality by providing an opportunity for the performer to work with physical interface units to demonstrate both interaction with the machine and to provide visual 'clues' to the spectator that the 'sounding flow' is being controlled 'live' by the performer. The 'Gamepad Selector' facilities a connection to a *Logitech Dual Action* controller.

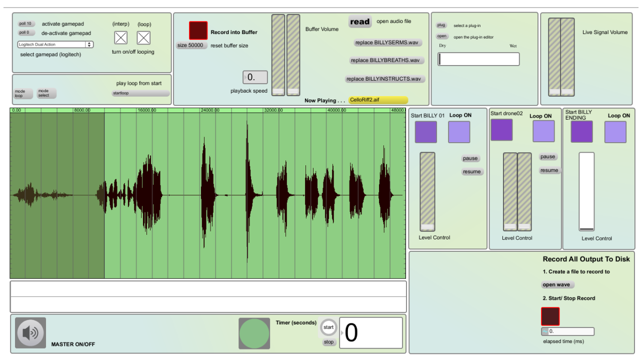

Fig.2: Multitasking Max/MSP patch used by MMUle

Audio samples to be used as performance materials can enter the patch at four locations: 1) the 'Record Into Buffer' – this captures all 'live' forms presented in the performance space; 2) the 'Pre-Recorded Buffer' – this makes available to the performer a selection of pre-recorded audio samples; 3) 'Live Capture' – this facility amplifies any incoming audio; and 4) three 'Pre-Recorded Loop Buffers' – this section provides pre-selected materials normally to be used as sonic support structures to facilitate audio transitions should they be required. Sound captured within either of the audio buffers can have its waveform represented at the 'waveform~' window. The audio waveform represented in the window can be manipulate through various interactive pathways: this includes adjusting the playback speed of the sample, working with external effects devices and manipulating the start and end points during playback of the waveform; eeach of these sample manipulating techniques can be controlled through the interface device.

[9] MMUle would like to thank Dr Jason Woolley for his initial work on the development of this patch. Jason was a core member of MMUle between 2008-10.

2.5. Conclusion

At this point in my journey along these two contrasting but complementary pathways towards developing an understanding of how 'live' and 'mediatized' forms have begun to co-exist in contemporary performance, I am reminded of the many deviations from the route I took that I was tempted to make, and, of course, these pathways will no doubt be returned to and explored in future MMUle projects. For the laptop musician developing work within an interdisciplinary context for 'live' performance through the sonic manipulation of 'live' and 'mediatized' materials there has been much fertile ground explored. The view from the horizon of the laptop now looks very different. Along the way I have discovered a variety of conceptual frameworks that have shed some light on the complex web of relationship that had needed to develop to begin to understand the mechanisms at work in 'live' laptop ensemble performance practice. Through the recent critical constructs developed within the area of intermediality, the network of connections has expanded to include not only the tripartite relationships between the performers and spectators, the performers and media, and the spectators and media, but also within the relationships between the different realities contemporary performance creates.

When turning our attention to the development of new instrumental designs, this has raised a number of still unresolved issues for the laptop musician to explore. For MMUle, the development of a computer laptop for use as a musical instrument seems almost synonymous with the issues surrounding 'live' laptop performance. The meeting places commentators such as Broadhurst, Cascone, Chapple and Kattenbelt, Emmerson, Kirby, Phelan and Power have identified as potential areas for further developments in locating new innovative practices, has provided a useful starting places for discovery. At the global level we have travel far on both pathways. However, the journey has been most productive when exploring the terrain at the micro level, be it locating the 'liminal' spaces identified by Broadhurst; the performance codes explored by Cascone; the intermedial relationships considered by Chapple and Kattenbelt; or, in fact, the importance placed on the development of 'presence' as part of a performance strategy by Kirby, Phelan and Power. These excursions have been the most productive in providing frameworks that now allow us to 'play' within considered structures. We are only just beginning to understand the creative potential of this new form of practice, but it is already having a major impact on the way

MMUle positions the computer as musical instrument in the wider context of its practice. There is still much work to be done to unpack the initial findings of this inquiry, however, by exploring the conceptual frameworks of other contemporary arts disciplines, it has been possible for MMUle to begin a voyage of discovery. Where this will lead to only time will tell.

3. REFERENCES

[1] Auslander, P. *Liveness: Performance in a mediatized culture.* London: Routledge, 2008 2nd ed.

[2] Bainbridge, L. "Man and machine in harmony", *The Observer.* 5th July 2009. Web. Accessed on the 3rd September 2011. http://www.guardian.co.uk/music/2009/jul/05/steve-reich-kraftwerk-pop-review

[3] Broadhurst, S. *Digital Practices: Aesthetic and Neuroesthetic Approaches to Performance and Technology.* Hampshire, Palgrave, 2007.

[4] Cascone, K. "Grain, Sequence, System: Three Levels of Reception in the Performance of Laptop Music", in *Contemporary Music Review.* 22:4, 2003. pp. 101-104

[5] Cascone, K. "Laptop Music – counterfeiting aura in the age of infinite reproduction," Web. Accessed on the 3rd September 2011. http://www.itu.dk/stud/speciale/auditorium/litteratur/musik/Kim%20Cascone%20Laptop%20Music%20v2.pdf

[6] Chapple, F. & Kattenbelt, C. *Intermediality in Theatre and Performance.* New York: Rodopi

[7] Dixon, S. *Digital Performance: A History of New Media in Theatre, Dance, Performance Art and Instillation.* Cambridge: MIT, 2007

[8] Emmerson, S. *Living Electronic Music.* Padstow: Ashgate, 2007.

[9] Emmerson, S. "Music Imagination Technology" in *Proceedings of the International Computer Music Conference*, Huddersfield, UK, 2011, pp. 365-372.

[10] Graham, G. "Music and Electro-sonic Art". *Philosophers on Music.* Ed. Stock, K. Oxford: Oxford University Press, 2007. pp. 209-225.

[11] Garner, Jr. S.B. *Bodied Spaces.* Ithaca: Cornell University Press, 1994.

[12] Kirby, M. "On Acting and Not-Acting", *Acting (Re)considered.* Ed. Zarrilli, P. London: Routledge, 1995. pp. 43-58

[13] Morris, J. "Structure in the Dimension of Liveness and Mediation" *Leonardo Music Journal* 2008:18 pp.59

[14] Musicians' Union. *Musicians' Union.* 2010. Web. Accessed 1st March 2012. http://www.musiciansunion.org.uk/

[15] Nelson, R. "Practice-as-research and the Problem of Knowledge", in *Performance Research.* 11:4, 2006. pp. 105-116

[16] Oscartripe. *Ella Fitzgerald sings for Memorex.* 5th May 2007. Web. Accessed 1st March 2012. http://www.youtube.com/watch?v=Bkt8Dwzl6Sg

[17] PARIP. Practice as Research in Performance. (no date) Web. Accessed on the 24th December 2011 http://www.bris.ac.uk/parip/introduction.htm

[18] Phelan, P. *Unmarked.* London: Routledge 1993.

[19] Power, C. *Presence in Play.* Amsterdam: Rodopi, 2008.

[20] Stuart, C. "The Object of Performance: Aural Performatiivity in Contemporary Laptop Music", in *Contemporary Music Review.* 22:4, 2003. pp. 59-65

NOTATIONAL APPROACHES FOR LAPTOP ENSEMBLES

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ABSTRACT

In this paper the authors will explore the notational approaches used while directing the Huddersfield Experimental Laptop Orchestra (HELO), HELOpg and other non meta-instrument based laptop ensembles. We will discuss the different notational methods used within my own compositional practice, suggest desirable notational features and suitability of such methods based on my own practice. In comparing western notation, graphic, graph, video, code and text scores we aim to identify a notational method suitable for the transfer of compositions between diverse ensembles.

1. THE LAPTOP INSTRUMENT

The features of the laptop instrument create a demanding notational problem. The lack of discrete or limited pitch ranges complicates the use of traditional western notation. The infinite sonority and its corresponding wide range of continuously variable parameters can transfer compositional intention into timbral detail, while also demanding a precision and rate of change beyond literal human performance. Additionally, the dynamic interface complicates the notation or purely physical gesture. These individual instrument issues also apply to ensemble practice.

2. A MISSING COMMON NOTATION

While laptop ensembles and orchestras have grown in number and popularity, there is still limited compositional exchange due to the different styles of ensemble currently active.

Before considering the individual instruments comprising an ensemble it should be notated that the variance in size and amplification (or the lack of in the case of Powerbooks Unplugged[6]) of the ensembles impacts on their ability to perform works, especially when works have been commissioned or premiered by another ensemble.

The Princenton Laptop Orchestra (PLOrk) operate a meta-instrument methodology[8] offering a single laptop instrument to compose for. Ensembles such as L2Ork seek to sustain external sonic compatibility[2] with other ensembles while implementing a different hardware and software solution. However other ensembles such as HELO and the Manchester Metropolitan University Laptop Ensemble (MMULE) have a diverse software and hardware make-up and consequently do not offer a single meta-instrument.

The ELO methodology[5] of diverse software and hardware and its inherent lack of meta-instrument identity, provides a unique opportunity for experimentation with notational approaches that are suitable for transfer between ensembles. It does however inherently complicate the exploration of game and network pieces such as *Hide and Seek* by A. Atmadjaja and J Eagust[4] and the development of network distributed systems like those created by Carnegie Melon Laptop Orchestra (CMLO)[3]

2.1. Desirable Notational Features

In exploring different notational approaches it is important to identify features by which methods should be judge and suitability established. Within the ELO methodology we feel that a notation should offer ease of transit between ensembles, precision with the conveying of compositional intent, flexibility to articulate ideas and ease of use ideally supported through familiarity. Any such notation should also avoid reliance on systems likely to face discontinuation or obsolescence. This is not an open source issue per say but rather an open data requirement, storing data in an accessible form. Doing so would allow the rebuilding of the score in a contemporary environment. A final concern of the notation is to enable and facilitate the role of the performer.

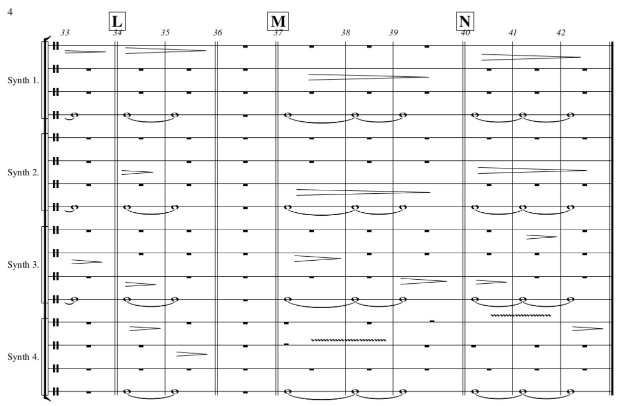
3. NOTATIONAL APPROACHES EXPLORED

Through collaborations and ongoing artistic direction the authors have had the opportunity to explore a number of notational approaches.

3.1. Traditional Western Notation

Traditional western notation seams an appropriate place to start and does offer immediate benefits. Within a traditional music context players have an understanding of notation and

Figure 1. Args 1



of its accepted conventions, [1] enabling quick comprehension of the score, especially in relation to linear temporal events. Within rehearsal of *Args 1* 1, this linear temporal representation facilitated quick rehearsal of the ensemble and the familiarity of the notation facilitated the addition of analogue synthesiser players.

While the rhythmical function of western notation is useful, its expression limited to "normal" note durations can be problematic, especially when considered in the light of the possible durational extremes such as, a sample to a crochet, to a day, such as offered by the programming language ChucK[9]. Likewise the discrete pitch focus of traditional western notation and the difficulty in conveying multiple changing parameters undermine the suitability of this kind of notation. It should also be noted that while the primary analysis parameters of notation continue to be important, the secondary notational parameters are often of equal significance within laptop performance practice.

3.2. Graphic Notation

The graphical score of *Christmas Carol Sonorities* 2 deliberately borrows heavily from the layout of a western score. With time on the horizontal axis, the graphical lines convey the sonic manipulations free of the context of pitch while still offering the advantageous linear temporal view.

While the graphical score offers the ability to communicate the time parameter, the highly interpretable graphical elements, combined with the near infinite number of parameters makes communicating fine detail problematic. As a consequence of the lack of convention, additional rehearsal and performer preparation time is required; often with limited gains as the interpretative skills are not necessarily transferable between works.

[1] It should be noted that for participants lacking this western notation training this familiarity does not exist.

Figure 2. Christmas Carol Sonorities

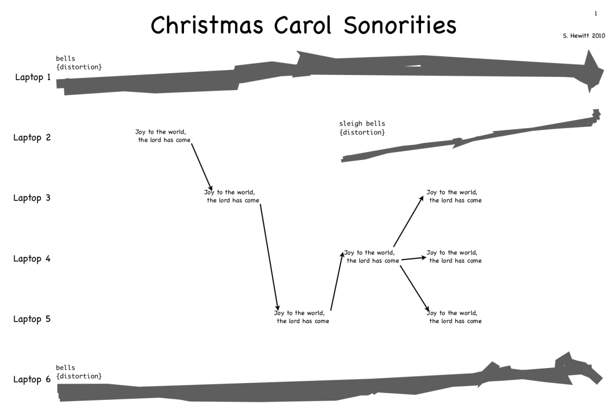
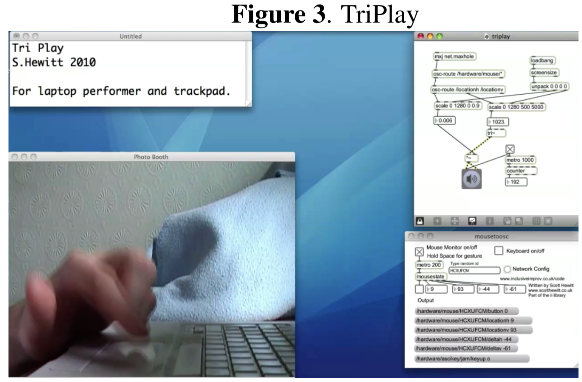


Figure 3. TriPlay



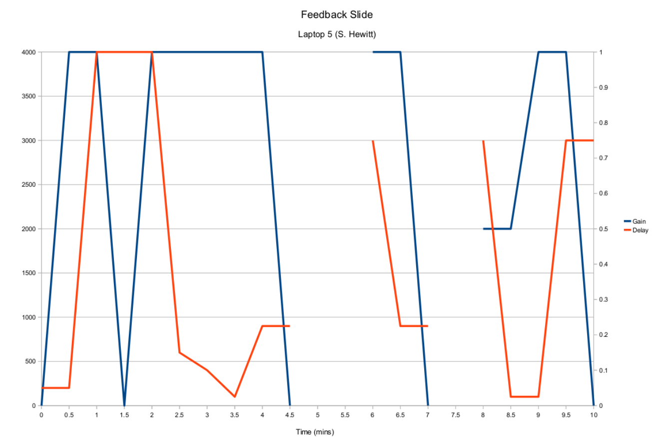
However the score is successful in communicating ideas of density and intensity, while presenting players a complete orchestral score allowing them to perceive the relative balance between players.

3.3. Video Notation

An extension to the graphical method is the use of a video scores. Through direction of HELO the video score was found to be effective in directing temporal events and indicating parameter changes through on screen movements. While this was initially explored through created video scores, later experiments were based around performing sound tracks for films and cartoons, the latter of which are inherently full of easily read and pre-empted cues. This notional method is also suitable for individual rehearsal but the video element, when shown to the audience, tends to become dominant.

Within the solo composition *TriPlay* 3 the video score captures the notational content, running code, physical gesture and sonic material. In doing so the score illustrates one of the unique features of the laptop instrument, the self-documenting performance. While this notational methodology meets many of the required elements the purpose in ad-

Figure 4. Feedback Slide



ditional performance seams limited now that a perfect performance is captured. Indeed while the score is a complete capture, it would be awkward to perform without a performance transcription.

3.4. Graph Scores

The graph score used for *Tower Whisper* offers an exact method of directing the players physical actions over a limited number of parameters. Alongside the score, the players are also directed to use composer-written software synthesisers, created in ChucK, on a prescribed interface, that of a MIDI fader. The first performance of *Tower Whisper*, performed by HELOpg and MMULE, requiring multiple performers on each physical laptop required only limited rehearsal prior to performance.

Likewise *Feedback Slide* 4 presented on acetate is intended to be easy to play and interpret with a very literal mapping between notational and physical gesture. This notated, performative gesture is achieved by suggesting the use of a physical fader, however the gesture could also be played on a soft fader or any chosen interface. [2]

While the simple mapping and obvious physical relationship is effective for direction, the compositional scope of the notation, especially regarding multiple parameters and discrete sudden changes is limited. Essentially the composers is forced to opt for either, precision in a limited number of parameters, or a broader direction of intent. Additionally combined with the potential machine readability, the purpose of the performance can seem unnecessary as often the part could be programmed rather than performed.

[2] While not currently explored it is anticipated that these scores will also prove to be machine readable however this would remove the attractive features of performance approximation and liveness.

3.5. Notation through code

The programmable nature of the laptop offers the opportunity to notate the laptop orchestra from within, either using the code as a notional vehicle or through the creation of the instrument and its interface. This instrumental feature could be used to defy the purpose of the performer however it may also be used to allow the performers to focus on important elements rather than the task of rehearsing accurate gestures.

3.5.1. Code as Score

OnRadio, a series of compositions, presents the performer with an application that transmits OSC-style messages over the localhost interface for implementation within the performers programming language of choice. The code as notation, conducting a performer's created instrument. This transfers the performer's role from one of a performer to the creator of the instrument, the luthier.

The composition *Envelope* was created in response to concerns of *OnRadio* application obsolescence by presenting a score intended for playback via code, on paper as a simple data set. In fact the data driving *OnRadio* could be presented similarly.

While code-based notation offer precession, ideal for certain compositional tasks, it proves to be unwieldy for more fluid, interpretative compositions. Also removing the performers ability to vary parameters denies the value of the performers expertise, the individuality of the location and may compromise the uniqueness of the performance.

3.5.2. Code as Instrument

As noted by Blackwell and Collins within contemporary music technologies 'the distinction. . . between notation and instrument, is becoming increasingly blurred' [1, p. 3], this is noticeable in the compositional act of creating an application for performance use. In the case of an application written for the laptop ensemble instrument, such as *On The Floor* [7], this is a notational tool similar to the device of orchestration. This approach does however force a unification of software, to the written application, often facilitated by a standardisation of hardware and consequentially is outside the ethos of the ELO approach.

3.6. Text Scores

The desire to re-engage the performer, and the successfulness of *Envelope* prompted the exploration of text scores for the compositions *InCode Prime* and *Human Shredders*.

InCode Prime has a simple compositional premise, capable of being expressed through any of the notational system discussed above (that of playing a sound at a particular time) however when presented as a text score it is very succinct. Rather than having to devise a completely notated score showing every sonic event, the rules governing their

occurrence are presented. These rules lend themselves to conversion to computer readable code while still providing an obsolescence-proof copy. In rehearsal with three laptop ensembles preparing *InCode Prime* for performance as part of the 2010 Manchester Science Fair, the score proved to be efficient, while still conveying the compositional intent.

Human Shredders instructs performers to write performance instructions, like code control sequences facilitating the involvement of players with a computer science background. The text score also illustrates it flexibility with forces as the score can easily include all styles of laptop performance and also non-laptop playing performers. While the score is highly indeterminate and offers the player significant authority, this is through design due to personal desire, it also facilitates players of all standards performing together while rewarding those with greater individual skill. It is however a score to be played rather than listened to.

4. CONCLUSION

The laptop instrument in solo, and even more in ensemble, lends itself to different notational methods as required by the composer. In composing for the laptop ensemble the difficulty is often in maintaining the purpose of the performers, as notation can rapidly become a poor substitute for programming or audio rendering. Traditional western notation can be used to arrange events in time however the discrete pitch focus of the stave is problematic.

The graphic score can be designed so as to maintain the familiar horizontal time representation, while escaping the discrete pitch construct and replacing it with a more continuous parameter. The video score is similarly effective in unifying events in time and provides scope for directing more continuous changes while also offering an effective individual rehearsal method.

For precision requirements graph scores are effective and simple to rehearse and use, especially when combined with an easily mapped interface. Though when designed for human playback the limited number of individually direct-able parameters can be awkward. The graph score material is also easily converted into a computer readable format, moving the performance action into the creative role of instrument design.

While difficult to use to notate quick changes, text scores has proven to be easy to rehearse, flexible in use and able to adapt to varying numbers of performers. It can be structured to appeal to the backgrounds of two common sets of participants, musical and computer science. Combined with a lack of dependency on any particular software or hardware, the text score has demonstrated the ability to express a compositional goal accurately, for players to perform as best enabled by their individual laptop instrument.

5. REFERENCES

[1] A. Blackwell and N. Collins, "The programming language as a musical instrument," Brighton, 2005.

[2] I. I. Bukvic, T. Martin, E. Standley, and M. Matthews, "Introducing L2Ork: linux laptop orchestra," Sydney, Jun. 2010.

[3] R. Dannenberg, S. Cavaco, E. Ang, I. Avramovic, B. Aygun, J. Baek, E. Barndollar, D. Duterte, J. Grafton, R. Hunter *et al.*, "The carnegie mellon laptop orchestra," *Computer Science Department*, p. 513, 2007.

[4] A. Harker, A. Atmadjaja, J. Bagust, and A. Field, "The worldscape laptop orchestra: Creating live, interactive digital music for an ensemble," Belfast, 2008.

[5] S. Hewitt, P. A. Tremblay, S. Freeman, and G. Booth, "HELO: the laptop ensemble as an incubator for individual laptop performance practices," New York, Jun. 2010.

[6] J. Rohrhuber, A. de Campo, R. Wieser, J. van Kampen, E. Ho, and H. Hlzl, "Purloined letters and distributed persons," in *Music in the Global Village Conference (Budapest)*, 2007.

[7] S. Smallwood, D. Trueman, P. R. Cook, and G. Wang, "Composing for laptop orchestra," *Computer Music Journal*, vol. 32, no. 1, pp. 9–25, Mar. 2008.

[8] D. Trueman, P. Cook, S. Smallwood, and G. Wang, "PLOrk: the princeton laptop orchestra, year 1," *ICMC*, 2006.

[9] G. Wang and P. R. Cook, "ChucK: a concurrent, on-the-fly, audio programming language," 2003.

ADAPTING ELECTROACOUSTIC REPERTOIRE FOR LAPTOP ENSEMBLE

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ABSTRACT

This paper introduces the Milwaukee Laptop Orchestra's realizations for laptop ensemble of three works, Gavin Bryars' *The Sinking of the Titanic* (1969), Scot Gresham-Lancaster's *Vague Notions of Lost Textures* (1987), and George Lewis and Marina Rosenfeld's *Sour Mash* (2009). These adaptations serve to situate laptop ensembles within a broader historical tradition of electroacoustic performance, demonstrate the lineage of works exploring unconventional modes of ensemble communication and compositional organization, and suggest that the process of realization and the experience of improvisation are both important opportunities for the creative empowerment of laptop ensemble performers.

1. INTRODUCTION

While laptop ensembles are a relatively new phenomenon, they form part of a larger continuum of ensemble performance with electroacoustic means. Antecedents include projects such as Karlheinz Stockhausen's *Mikrophonie I*, John Cage's *Reunion,* and David Tudor's work with Composers Inside Electronics, as well as ensembles such as Musica Elettronica Viva, the Hub, and Fenn O'Berg. Shared aesthetic programs, including sonic and textural exploration, the integration of indeterminacy and improvisation within compositional structures, new forms of ensemble relationships and communication, and formal innovations, outweigh the differences embodied in the specific technological forms of pre- and post-laptop electroacoustic ensembles.

Adapting the pre-existing electroacoustic ensemble repertoire for laptop ensemble performance helps to connect laptop ensembles to this broader context of aesthetic intent and technological practice. It creates an opportunity to consider how a wider repertoire might inform the objectives and structures of new ensembles, as well as their specific compositional and improvisational practices. And it helps to creatively empower the musicians involved, engaging them with issues of interpretation, improvisation, and aspects of musical realization traditionally concerned the sole province of a single composer. This paper will consider the adaptation of three such works for electroacoustic ensemble - Gavin Bryars' *The Sinking of the Titanic* (1969), Scot Gresham-Lancaster's *Vague Notions of Lost Textures* (1987), and George Lewis and Marina Rosenfeld's *Sour Mash* (2009) - by the Milwaukee Laptop Orchestra (MiLO).

2. THE MILWAUKEE LAPTOP ORCHESTRA

Specific features of MiLO have strongly influenced the selection and character of these realizations. While based at the University of Wisconsin-Milwaukee, the ensemble does not have an official status within the Music Department. Instead, MiLO operates at the pleasure of its musicians, as a purely extracurricular activity, and alumni and community members participate alongside UWM students and faculty. Leadership is distributed, to the point that the ensemble verges on the anarchic: "fast, cheap, and out of control" (with apologies to Errol Morris) is a group mantra.

Free improvisation is the basic practice of the ensemble. This premise allows instrumentalists, vocalists, and visual artists to perform together with electroacoustic musicians (as has been the case from our earliest performances). It also enables electroacoustic performers to use any combination of hardware and software available to them; while that primarily means Mac or Windows laptops running Pd or Max/MSP, more idiosyncratic choices include hardware such as the Nintendo DS and circuit-bent consumer Yamaha keyboards, and software such as DJay, Reason, and cepstral.com. Compositions made for or realized by the ensemble have to negotiate with this diverse array of performance, media, and technological approaches in some way (including the possibility of excluding some group members).

3. SELECTED REALIZATIONS

Adaptations of pre-existing repertoire made by members of MiLO, either individually or collectively, include the three works listed above as well as Scot Gresham-Lancaster's *Stuck Note* (1994) and Steve Nelson-Raney's *Sextet 1999*. All these works were originally created for ensemble performance, and, with the exception of the Nelson-Raney, all conceived of with electroacoustics as a key element. (Nelson-Raney is a member of MiLO - hence our enthusiasm for his graphic score). They are also all pieces

which speak to contemporary aesthetic practices currently being explored by laptop ensembles - innovative forms of ensemble relationships and communication (especially via the use of data networking in the Gresham-Lancaster pieces), blurred boundaries between performer and composer (particularly in the Bryars), and investigations of structured improvisation (in all of the works). While none were conceived specifically for laptop ensemble, they are all "good fits" logistically and technologically (not least because all five offer significant flexibility to the performers), and they respond to the specific ideals and organizing principles for MiLO described above. As older works, the Bryars and Gresham-Lancaster have the added advantage of helping to articulate a historical lineage for electroacoustic ensemble performance. MiLO's realizations of *The Sinking of the Titanic*, *Vague Notions of Lost Textures*, and *Sour Mash* are discussed at greater length below.

4. THE SINKING OF THE TITANIC

Gavin Bryars describes *The Sinking of the Titanic* as "an open [piece], being based on data about the disaster but taking account of any new information that came to hand after the initial writing. All the materials used in the piece are derived from research and speculations about the sinking of the 'unsinkable' luxury liner." [1] Bryars' 1994 recording of the work suggests the prominent use of the hymns *Autumn* and *Aughton*, one of which may have been the final piece of music performed by the band on deck. Other *Titanic*-related elements include recordings of survivor testimony and ocean waves, morse code rhythmic material, water gongs, and extensive use of electronic reverberation (many of the "speculations" included in the published score center on the propagation of sound in cold water, and an imagined potential for near-infinite echo and reverberation in the North Atlantic environment) [2].

For a MiLO realization of the piece in Fall 2010, each member of the ensemble was invited to develop their own material relating to Bryars' concept and instructions. The group's responses included instrumental and vocal performance of the hymns traditionally associated with the band on deck (including realtime signal processing of the voice), as well as synthesized and manipulated versions of those same hymns (including a set of renderings time-stretched to twenty-five minutes in length). Other musicians chose to perform using electroacoustic transformations of recorded survivor testimony, and of ocean waves; one member projected live manipulations of video footage recorded by Robert Ballard of the underwater wreck. The ensemble as a whole then worked together to fit these materials into a loose formal structure roughly a half-hour in duration. This structure included correspondences with Bryars' own 1994 realization of the work: alternations between clearer presentations of the hymns and more improvisatory interludes, a switch from *Autumn* to *Aughton* after the midpoint of the work, and a overall *decelerando* and registral descent suggestive of sinking and freezing.

The piece proved not only a compelling concept and process on which to hang a long-form improvisation, but also a very effective vehicle for creatively empowering the various members of the ensemble. Individual performers were able to contribute at the level of their individual skillset, using whatever hardware and software tools were available to them, and the very focused materials and formal process (together with extensive collaboration and rehearsal) helped to guide a convincing improvisation. The independent action of each performer also helped to resolve the "self-recognition" problem (in Dan Trueman's terms, issues of "sonic presence" and "performative attention" [3]) in which a laptop performer operating in a massed sonic context cannot perceive their own contribution to the sound of the whole, let alone identifying the specific contributions of fellow performers. While MiLO's realization of *The Sinking of the Titanic* was undoubtedly thick and drone-oriented, the highly differentiated roles for each performer brought considerable clarity to the situation - a strategy paralleled in our approach to *Vague Notions of Lost Textures* (and contradicted by our realization of *Sour Mash*).

5. VAGUE NOTIONS OF LOST TEXTURES

MiLO performed Scot Gresham-Lancaster's *Vague Notions of Lost Textures*, originally composed for the "network band" the Hub, in February 2008. Hub members Chris Brown and John Bischoff describe the piece as a messaging system facilitating "co-ordination of the improvised music around a formal shape: a simple ramp of increasing note density, timbral brightness, and amplitude that peaked at around 80% of the agreed upon duration of the piece, followed by a smooth return to a texture of low density, brightness, and amplitude, where the music stopped. Chats kept track of the progress of the band through this shape, and were often used to describe the character of the music that resulted, providing a running commentary on how the performance was going." [4] Networking - in the familiar form of text-based chat - is essential to the piece, and we were curious to explore how this additional channel of communication might influence our performance.

MiLO's rendition of this piece (which included projected visuals showing the audience the chat in progress) was built on NRCI, a suite of tools facilitating networked improvisation built in Pd, Processing, and Supercollider [5]. The chat facility provided a fascinating augmentation of listening, as the ensemble was able to communicate through the musical performance itself, while simultaneously providing metacommentary on the performance through instant messaging. The visuals

provided a welcome theatrical component, especially as a degree of comedy entered into the performance of the chat (interesting to note that this appeared only in concert, and never occurred in rehearsal!) The projections also helped to illuminate for the audience what otherwise might have exemplified the cliché of inscrutable laptop performance. As with the Bryars, the performers were able to use NRCI's chat facility alongside whatever sound-generating tools they favored for the improvisation (in several cases running Pd solely for use of the chat function) - an approach in keeping with the individualized performance setups favored by the Hub in the 1980s and 1990s.

6. *SOUR MASH*

George Lewis and Marina Rosenfeld's *Sour Mash* is the only composition dating from the era of laptop ensembles, though it appears to have been conceived primarily for performance by multiple DJs (with the potential for performativity that comes from the virtuosic deployment of vinyl). Rosenfeld and Lewis provide a reservoir of thirty minutes of audio material for remixing, either from CD or LP. In their words, it is "an open-ended composition, or palette, for further creative recombination by one or multiple performers." [6]

For MiLO's performance (in October 2010), every member of the ensemble ran an identical Pd patch, which facilitated the location, playback, and mixing of Lewis and Rosenfeld's source audio, while simultaneously streaming performance data to a Processing sketch displaying a networked animation (see Figure 1). The shared audio

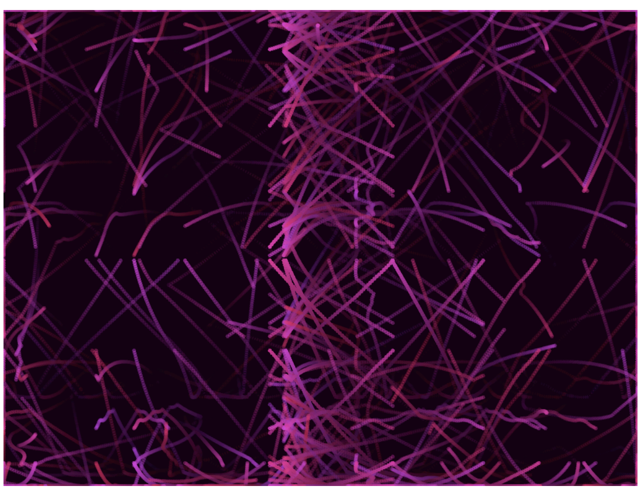

Figure 1. Still from networked animated visualization accompanying *Sour Mash*.

material facilitated a very different kind of improvisational dialogue than encountered in the Bryars or Gresham-Lancaster. Where the previously described works emphasize drone, independence of action, and multiple streams of simultaneous activity, Lewis and Rosenfeld's highly directional and collage-oriented materials invite performance which is more gesturally-oriented, fluid, and rapidly changing. Since all of the musicians share the same sonic repertoire, Lewis and Rosenfeld also create a distinctly group-oriented (rather than individual-centered) context for improvisation, tending to blur or integrate the sonic identity of individual performers. While networking facilitated the visual aspect of the performance, we chose to emphasize musical/audible communication between the performers over a networked approach in this case.

The performance gestures made by MiLO (using MIDI fader controllers) may not have reached the level of virtuosic turntablism, but the realization did build on the ideas about clarifying and amplifying visuals originally developed in the Gresham-Lancaster adaptation. In this case, networked visuals of an abstract particle animation were used to present visual analogies for each individual musician's performance choices (regarding sound material, panning, muting, and overall output amplitude) to the audience.

7. CONCLUSIONS

These realizations suggest that improvisation can be a crucial strand of laptop ensemble music-making. While all three projects invoke some degree of compositional structure, they also invite significant, meaningful, and independent choices both before and during performance, to the point of allowing for independent choices of musical tools and techniques in the Bryars and Gresham-Lancaster. As a result, these projects foster creative empowerment, even for relatively inexperienced ensemble members. At the same time, the clear concepts and structures of these works serve to define standards for performative excellence for the musicians to aspire to; in rehearsal with MiLO, it was always very clear when performances were and weren't "working."

The process of realization itself is another form of creative empowerment. Ensemble members participating in the Bryars and Greshman-Lancaster were compelled to find creative ways to use their tools (and in many cases to develop their skills) to satisfy the specifications of the compositions. With the Bryars in particular, the group engaged in intense discussion about the appropriateness of various materials, and the formal structure in which those materials were placed – confronting the ideas of a composer in detail, and endeavoring to do those ideas justice in performance.

Both the Gresham-Lancaster and the Lewis/Rosenfeld works represent unusual models of ensemble performance, which merit further development in the laptop ensemble context. In *Vague Notions of Lost Textures* the priority given to back-channel communication exemplifies the divided attentions of contemporary life, and the ways in which we operate in virtual and real worlds simultaneously. In *Sour Mash* the shared pool of audio material creates a variety of possible roles for performers:

they can share an "identity," "compete" over material, or differentiate themselves from their peers.

The realizations described here all incorporated video projection. In the case of the Bryars, video was used primarily for aesthetic ends, adding an additional element of atmosphere and creating another formal trajectory across a second sensory dimension. The Gresham-Lancaster suggests a more technical approach, in which video projection serves primarily to reveal the "behind-the-curtain" workings of the performance (similar to the live-coding practice of screen-mirrored projection). The Lewis and Rosenfeld realization aims for an intermediate position, in which animation serves an aesthetic end, but also reflects and translates moment-to-moment choices about sound material made by the musicians.

All three of these realizations work to situate laptop ensemble performance within a longer tradition of ensemble electroacoustic performance, and demonstrate the ways in which ideas about networked communication, multimedia, structured improvisation, and performance gesture have been anticipated by composer/performers working in that broader context of music-making. Given the intensifying pace of technological change (of which the current industry emphasis on "post-PC devices" is just one exemplar), we risk a swift obsolescence for the laptop ensemble concept (and its many virtues) if we don't make such connections. Adaptations such as the works presented here are opportunities to connect with the historical continuum of electroacoustic ensemble performance (and with twentieth- and twenty-first century music-making more generally), and to widen our conceptions of laptop ensemble performance technologically and aesthetically.

8. REFERENCES

[1] Bryars, G. *The Sinking of the Titanic*. Point Music CD 446-061-2.

[2] Bryars, G. "The Sinking of the Titanic," *Soundings* 9 (Berkeley, California).

[3] Trueman, D. "Why a laptop orchestra?" *Organised Sound* 12/2: 171-179 (Cambridge, UK).

[4] Brown, C., and Bischoff, J. "INDIGENOUS TO THE NET: Early Network Music Bands in the San Francisco Bay Area." http://crossfade.walkerart.org/brownbischoff/IndigenoustotheNetPrint.html

[5] Burns, C., and Surges, G. "NRCI: Software Tools for Laptop Ensemble." Proceedings, International Computer Music Conference, 2008.

[6] Lewis, G., and Rosenfeld, M. *Sour Mash*. Innova CD 228, 2010.

DON'T FORGET THE MACHINES: ORCHESTRA OF HUMANS, LAPTOPS, AND ROBOTS

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ABSTRACT

This paper describes the Machine Orchestra: a laptop ensemble of human performers and custom built robotic musical instruments. It also discusses how the technology and orchestra framework is used as a vehicle for storytelling with our first production called “Samsara”.

INTRODUCTION

In 2006, Dan Trueman and Perry Cook unleashed the Princeton Laptop Orchestra (PLOrk) [1, 2], setting a new paradigm for teaching, performing and composing computer music. At the time, there was very little precedence of having multiple performers on stage performing on laptops together, and most performances were limited to one musician. Additionally, the projects that did involve multiple laptop musicians such as The Hub[1], generally had less than four performers on stage, nowhere near the 16 -25 in PLOrk. With the invention and mass production of the Hemispherical Speaker [3], it was finally possible for each PLOrk musician to have their own sound source on stage. This permitted the audience to perceive the laptop musicians output localized to where the sound was emanating from in the orchestra, as opposed to the traditional method of a stereo PA mix [4]. A key paradigm shift surfaced in how a “Laptop Orchestra” could be used in education to teach computer science, composition and performance to the computer musicians of the future [5].

And thus began the “Age of the LOrk.” In 2008, Ge Wang, a pivotal member of the original PLOrk, emerged from the Stanford Center for Computer Research in Music and Acoustics (CCRMA) and founded the first LOrk on the west coast, The Stanford Laptop Orchestra (SLOrk). Near the same time, other laptop orchestras began appearing around the world. Direct collaboration with SLOrk and PLOrk led to the creation of the Oslo[2] and Boulder[3] Laptop Orchestras. Other groups unaffiliated with educational institutions also started to materialize, including the Moscow[4] Cyberlaptop Orchestra, the Tokyo[5] Laptop Orchestra, and the Seattle[6] Laptop Orchestra. In 2009, The Virginia Institute of Technology[7] founded the first LOrk created through fully open source technology, aptly named the Linux Laptop Orchestra, L^{2}Ork. The concept of a LOrk has also transitioned to mobile devices, with the first mobile phone orchestra (MoPho) performing in 2008 [6]. Since then, other networked ensembles of phones have surfaced, including the Michigan[8] Mobile Phone Orchestra, The Helsinki[9] MoPho, and the Berlin Mobile Phone Orchestra.

Influenced by all these projects, our team endeavored to design our own “LorK” inspired laptop orchestra. Adding the pedagogical disciplines of the “Lorks before us”, our project focuses on training new computer musicians on other skills including: metal machining, mechanical engineering, interface design, and musical robotics. These additional elements which are unique to the Machine Orchestra, and which are instrumental to the CalArts Music Technology curriculum, were realized by combining forces of the CalArts Music department with the CalArts Theatre Department who train students to be Technical Directors and Production Managers. This presentation describes the making of the Machine Orchestra, a unique ensemble that combines custom musical interface design, hemispherical speakers, networked performance, musical robotics, dance and animation.

1. THE MACHINE ORCHESTRA

The core of the Machine Orchestra lies upon a custom built network that interconnects a variable number of human computer musicians, to a variable number of custom built robotic instruments. These robotic instruments [7] include MahaDeviBot, GanaPatiBot, Tammy, BreakBot, GlockenBot, NotomotoN [8], JackBox, and more machines constantly in development. These robotic machines further

1 http://en.wikipedia.org/wiki/The_Hub_(band).
2 http://fourms.wiki.ifi.uio.no/Oslo_Laptop_Orchestra
3 http://cismat.org/blork.html
4 http://cyberorchestra.com/
5 http://laptoporchestra.net/
6 http://www.laptoporchestra.com/
7 http://l2ork.music.vt.edu/main/
8 http://mopho.eecs.umich.edu/
9 http://www.acoustics.hut.fi/projects/helsinkimopho/

push the aesthetic of having sound coming from multiple sources, as many robots are often placed in the audience depending on the production and venue. The robots serve as a shared network instrument [9], in which all members can communally control each actuator depending on the composition and framework of a particular piece.

The Machine Orchestra is rehearsed in the Machine Lab at CalArts, where the robots are hanging from ceiling all connected to a central server. Students and faculty can easily connect to the server and start composing and performing within minutes with very little set up time. The robots take multiple days to setup in the room, so a dedicated room for development is essential to the Machine Orchestra's success.

The Machine Orchestra has performed 10 concerts up to date mostly locally in Los Angeles, but venturing to San Jose, Georgia, and even New Zealand. Traveling with the robotic instruments is a difficult obstacle, and certain robots were built specifically to fit in a suitcase and travel on a plane. The orchestra has collaborated with key electronic artists such as Perry Cook, Curtis Bahn, Tomie Hahn and Trimpin, who have all helped give a diverse repertoire of music[10].

Figure 1. Machine Orchestra at REDCAT, Jan. 27, 2010.

2. A MEDIUM FOR STORYTELLING

The next era of evolution for the Machine Orchestra is to use the technology and infrastructure as a medium for story telling. The first attempt at this was in the world premiere of *Samsara* on April 12, 2012 at REDCAT in the Walt Disney Hall Complex. This involved expanding our team to include animators, dancers, actors, storytellers, and production designers.

Samsara means reincarnation. Hindu and Buddhist philosophy embraces the concept of reincarnation as a way to learn, grow, and evolve. *Samsara* pulls inspiration from ancient morality fables found in the *Panchatantra* and the *Jataka Tales*. These fables often use a mixture of humans and animals in each story. *Samsara* is uniquely positioned to use the inventions of the Machine Orchestra to perform these stories in a novel, unconventional way. For example, for the story of the *Bee,* Trimpin designed a set of 12 robotic spinning bees that are installed above the audience. As each one individually turns on, the instrument can be used to make it seem like the bee is moving from one part of the auditorium to the next.

With *Samsara,* old stories are embraced in a new way combining music, dance, theatre, and technology. *Samsara* marks the beginning of a new era for the Machine Orchestra and our production team, where all the arts collide into one large production to help use the technology as a vehicle for storytelling.

3. REFERENCES

[1] Trueman, D., *Why a laptop orchestra?* Org. Sound, 2007. **12**(2): p. 171-179.

[2] Trueman, D. and e. al., *PLOrk: The Princeton Laptop Orchestra, Year 1.*, in *Proceedings of the 2006 International Computer Music Conference*. 2006: New Orleans, Louisiana.

[3] Trueman, D., C. Bahn, and P. Cook, *Alternative Voices for Electronic Sound: Spherical Speakers and Sensor-Speaker Arrays (SenSAs)*, in *Proc. of the International Computer Music Conference*. 2000: Berlin, Germany.

[4] Smallwood, S., et al., *Composing for laptop orchestra.* Comput. Music J., 2008. **32**(1): p. 9-25.

[5] Wang, G., et al., *The laptop orchestra as classroom.* Comput. Music J., 2008. **32**(1): p. 26-37.

[6] Wang, G., G. Essl, and H. Penttinen, *MoPhO: Do Mobile Phones Dream Of Electric Orchestras?*, in *Proceedings of the International Computer Music Conference*. 2008: Belfast, Northern Ireland.

[7] Kapur, A. & M. Darling "Building Musical Robots for the Machine Orchestra," *Proceedings of the IEEE International Conference on Intelligent Robots and Systems, pg. 25-30, Taiwan,* October 2010.

[8] Kapur, A., Darling, M., Murphy, J., Hochenbaum, J., Diakopoulos, D. & Trimpin, "The KarmetiK NotomotoN: A new Breed of Musical Robot for Teaching and Performance," *Proceedings of the International Conference on New Interfaces for Musical Expression,* Oslo, Norway, June 2011.

[9] Vallis, O. & A. Kapur, " Community Based Design: The Democratization of Musical Interface Construction" The Leonardo Music Journal

[10] Kapur, A., Darling, M., Diakopoulos, D., Murphy, J., Hochenbaum, J., Vallis, O., & C. Bahn, "The Machine Orchestra: An Ensemble of Human Laptop Performers and Robotic Musical

WEB BASED CONTROL OF MOBILE ENSEMBLES

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ABSTRACT

Composer-programmers for laptop ensembles have a similar problem to solve for each and every piece - that of how the user and/or performer will interact with the software instruments. The separation of user interface from audio production, or view from controller in programming parlance, has created an interesting paradigm wherein different mappings of gesture to sound and levels of direct versus mediated control can be explored. Although there has been a recent push towards HCI peripheral based interactions, a proliferation of touch screen devices has renewed exploration in screen based user interfaces which are consequently expanding in some exciting new directions. The distribution of user interfaces through web techniques offers most of the same functionality that traditional screen and touchscreen based user interfaces have to offer, but provides a number of intriguing new possibilities. So what is gained through using a web approach?

Flexible User Interaction: HTML 5 and Javascript provide a touch enabled 2D (a 3D implementation is being developed) graphical canvas in which to create a user interface element. Traditional dials, buttons, sliders, region selectors, and keyboards can be created, including multitouch versions. Also, HTML5 has support for accelerometer data and geo-tagging which open up interesting new possibilities. Layout can be handled through CSS which allows the UI to adapt to different screen formats. Just about anything that can be done in creating a normal graphical user interface, one can do through the browser.

Distribution Possibilities: If a web based user interface is paired up with a web distribution mechanism like a Ruby on Rails Web Application, a distributed network of users can be managed. Advantages of the web distribution approach are: cross platform support for most browser enabled devices (e.g. coding once for everyone), distribution of interface to a scalable number of performers, aggregating, tracking and managing data from many concurrent users, and tried and true tools for handling network accessibility and scalability.

Flexibility in Implementation: Web based interfaces can be implemented in a number of ways; directly on a laptop, controlling the same machine; through a shared web application providing controls to many machines; and through a device specific browser for maximum responsivity.

Reusable Code: All of these examples can be done with the same user interface code (or with extremely small changes in code). One user interface can be made and deployed to a local laptop, an indivicual or multiple cell phones, an ipad, a collection of tablet computers, touch screen computers, or all of them at the same time. The only thing that needs to change is how the system handles the data that is receive. Adjustments to the system can be made to support many concurrent users or extreme responsiveness, but this hardly affects the underlying web based UI code.

This presentation will cover recent developments in NEXUS: a Ruby on Rails based approach to distributed performance systems, the NexusUI library for HTML5 and javascript based user interface objects, an iOS and Android based NexusUI host for responsive user interaction, and how these techniques can be applied in a mobile ensemble context. Application of these techniques will be drawn from the work Perception, a series of compositions for Laptop Orchestra and audience participation.

4QUARTERS: REAL-TIME COLLABORATIVE MUSIC ENVIRONMENT FOR MOBILE PHONES

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ABSTRACT

This paper presents '4Quarters,' a new musical multiplayer compositional and mixing tool designed for the iPhone and computer. 4Quarters is designed for the general public to serve as an alternative to a consumption-based approach to music (simple playback). It also aims to depart from interactive score-matching games such as Rock Band by offering an open-ended architecture for sound selection. Sounds are based primarily on prerecorded audio files, but playback is non-linear and determined by keypresses in real-time. The ultimate purpose of this software is to provide a structure for making music that is fundamentally decentralized and collaborative in nature, where prepared content, live manipulation, and the final recording of the music is brought to pass by multiple participants. In this paper I describe the setup in terms of network configuration, mapping strategies, visual feedback, and content/retrieval architecture. Observations of the tool in beta performance are also discussed.

1. INTRODUCTION

Within the last decade there has been an explosion of applications and research for mobile phones in musical contexts, frequently with diverse intents, outcomes, and uses of mobile technology. Reports on the community by Levin [10], Behrendt [2], Tanaka [15], Gaye et al [7], Oh, et al [13], and Essl & Rohs [4] underscore the rapid rate of transformation of work, which is in part due to the increased capabilities of mobile devices [9][16]. Here I will focus primarily on mobile music scenarios that depend on multiple mobile devices. Golan Levin's *Dialtones: A Telesymphony* (2001) was one of the first pieces that took advantage of the notion that concert halls are typically filled with people carrying mobile phones, and that these devices can be used for musical purposes [11]. David N. Baker's *Concertino for Cellular Phones and Symphony Orchestra* (2006) likewise acknowledged the ubiquity of mobile phones by encouraging audience members to play their ringtones at specific sections in the piece [18]. Jason Freeman's *Glimmer* (2004) does not make use of mobile phones, but is likewise an ambitious audience participatory piece using glow wands and motion capture [6]. Joshua Knowles and Joo Youn Paek's *Phoneplay* (2007) allowed participants to dial into a central server with keypresses helping to shape a pan-diatonic soundscape [9].

Yet in each of these scenarios the role of the lay participant is rather limited in influence. 4Quarters was likewise conceived to cater to a broad public, but to give each participant a greater influence on the musical outcome, or at least ensure that each participant can receive some feedback that he/she is influencing the music. Successful commercial games Rock Band and Guitar Hero address this issue by providing effective visual and audio feedback, but when all is said and done, the role of the participant is closer to performer rather than composer [12]. 4Quarters likewise provides pre-recorded content for a participant to 'play', but the content is presented as an array of loops to mix and match in a non-linear format.

2. RELATED WORK

Group music making has been a central focus for many mobile music scenarios [8] and network music architectures [1][22], some of which are geared towards ad-hoc jam sessions [5][17][23] while others [3][14][20][21] are situated in formal ensemble settings such as Stanford MoPhO, The Michigan Mobile Phone Ensemble, the Helsinki MoPhO, and the Yamaha Mofiano Mobile Orchestra [13]. Mobile phone instruments such as RjDj and Smule's Ocarina extend the possibilities for social interaction by leveraging locative data and online communities [19]. Within this context, 4Quarters is designed primarily for ad-hoc performance scenarios, though it can be adapted for concert pieces and in the future may include an online repository for generated works.

3. DESIGN CONSIDERATIONS

3.1 Evolution of design

In its original conception 4Quarters was intended to accommodate a wide variety of devices situated in the realm of audience participation. Similar to Joshua Knowles and Joo Youn Paek's *Phoneplay* (2007), a visual projection would show all participants' activities. The initial visual design was intended to correspond to the familiar 12-key interface found on mobile phones. Various types of assignments were conceived to work with the 12-key tactile interface. Preliminary designs anticipated multiple phones communicating keypresses to one central server, with all sound processing occurring on that server. Participants would link in by dialing a phone number, and DTMF keypresses would be captured via Asterisk and route the data to Max/MSP.

The arrival of the iPhone introduced new possibilities for data input and interface considerations, such as customizable interfaces with sliders, additional buttons, and colors. Latency with wifi was also much less of an issue, and subsequently plans to use DTMF and Asterisk as the network protocols were abandoned in favor of OpenSoundControl and a wireless LAN. The switch was also made to prepare for the likely transition where most phones worldwide will be smartphones.

3.2 Network configuration

The main software environment is designed in Max/MSP with iPhone/iTouch serving as controllers, sending user input via OpenSoundControl over a wireless network. TouchOSC is the current client app, which sends and receives data to and from Max (see Figure 1). Outgoing messages from the iPhone/iTouch control the following sonic parameters: sound file selection, looping, volume, panning, and EQ. These messages each have a corresponding visual indication on a projected screen that can be seen by all participants. Audio processing is handled within Max, with the stereo image output ideally routed to external speakers.

Data received on the client side provides visual feedback reinforcing the interface correspondence between the main video projection of the Max patch and the screens viewed on the phone.

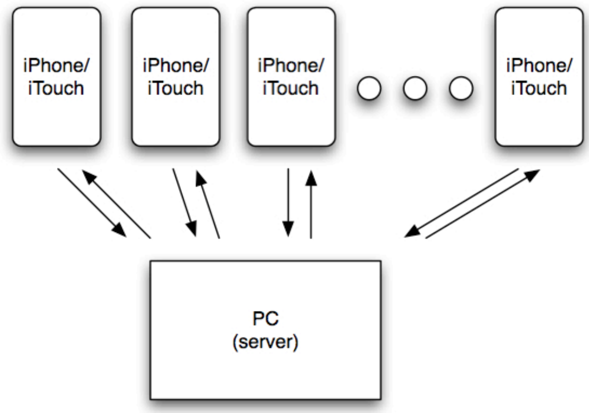

Figure 1. Up to twelve iPhones send and receive OSC messages to/from a server via a wifi local area network.

3.3 Server Interface

The 12-key concept as an interface orientation has remained as a carryover from the initial design. Keypresses from a 12-key mobile phone map onto a 4x3 grid interface (numbered 1-12), with the master patch showing four iterations of this grid. Each of the four grids represent sound layers, with each containing twelve sound files available for playback, making for a presentation of 48 samples at any one time. These are visually delineated into uniquely colored quadrants in the main Max patch (see Figure 2). Those colors become helpful indicators in situations where multiple participants work to control one layer of sound. For instance, 'team red' may have one person in charge of sound file selection, another person controlling volume, and a third person shaping the EQ. Ideally that patch is projected on a large screen so that all participants can see clearly what is going on in the other layers/quadrants.

Figure 2. Master interface that all participants see.

In the master patch, each number represents a sound file, and the file's name and waveform diagram are visually placed adjacent to that number. Additionally, a small fader is placed next to the waveform diagram (see Figure 3).

When in play, each waveform diagram has a scrollbar, which becomes a significant feature in coordinating synchronization between sounds. If sound files are groove-oriented and follow a particular BPM setting, synchronizing the timing of playback must be handled manually. By design there is no tempo map or beat grid that synchronizes playback, with the intent to engender musicianship and social cooperation to get the timing right.

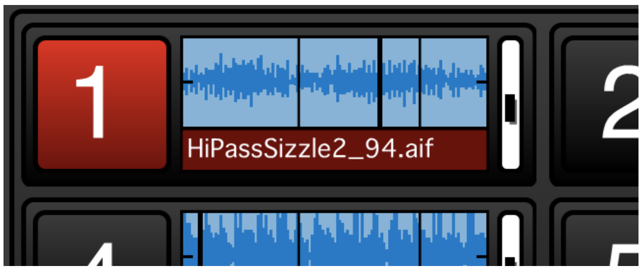

Figure 3. Close up of one sound file 'frame,' with waveform diagram, scrollbar, file name, and fader.

3.3 Audio Content

In terms of physical design, a stereo image comes from the server laptop or PC, ideally connected to speakers. This of course means that the phones do not physically produce sounds, but serve only as controllers. And this of course inherently creates limitations for the physical spaces and places where 4Quarters may be used. So the *mobile* aspect of mobile phones is not leveraged to its greatest potential here. Concert halls, living rooms, or classrooms are the most likely spaces for implementation, as they may have built-in audio systems, decent speakers, and projectors. Though the ability to have a phone act as the server is possible and certainly attractive [9], tethering the phones to a computer is already a necessity for the visual component.

Audio content is comprised of a series of pre-recorded audio files that are then available for real-time playback, looping, and rapid file selection. The framework is open in that a user can drag and drop audio files into sound banks. Twelve sound files may be ready-at-hand for each bank, and up to five banks of twelve files are available to be called up and swapped in and out (labeled A-B-C-D-E). Thus, 240 total sound files can be accommodated.

Because users frequently want to make things happen rather than sit back and listen, the best sound files tend to be short in duration, loopable, and composed to fit 'hand to glove' with other files. One possible format for composition is to have each bank from all four layers correspond in some fashion, with global formal structure characterized by parametric change from one bank to the next. This might be a way to suggest or imply formal guidelines for groups to use in improvising when selecting and synchronizing layers of sound.

3.4 Performance Assignments

There are three distinct roles within one layer/color that players can take: 1) file selection (including swapping sound banks), 2) volume/panning, and 3) EQ. Three corresponding pages of a custom TouchOSC layout form the phone interface (see Figure 4).

The first role, file selection, allows a user to choose from a maximum of twelve files at any one time. File selection and playback is controlled entirely by keypress. As a default pressing buttons triggers only one sound file at a time, though a poly feature allows multiple files to playback at once. A stop button and loop button are additional controls, as well as buttons controlling sound bank selection.

Volume and panning are dedicated to the second page of the TouchOSC layout. Here one plays the role of mixer, adjusting the volume levels of the various sound files, and controlling global volume. One can opt to affect both panning and the master volume on the touch screen via slider, or one can toggle a button to use accelerometer data. Panning (X axis) and global volume (Y axis) data is routed to Max, which in turn send messages back to the phone to activate the sliders visually on the phone.

Basic EQ is controlled on the third page with an XY slider. The X axis affects the peak frequency and the Y axis is mapped onto the Q. There are six filters (with allpass as a default) for modifying timbre. Like volume, EQ can also be controlled via accelerometer data.

Figure 4. Three iPhone/iTouch layouts control sound file selection, volume/panning, and EQ.

If desired, one player can take on all three roles. With four colors, this means that a minimum of four players can

operate all available control parameters, and a maximum of twelve can play. In the scenario of one player controlling file selection, volume, and EQ, it can become difficult to swipe from one page to the next on the TouchOSC layout. Hence, on the first page (file selection) there are buttons that can switch on the tilt options for panning, volume, and EQ.

4. OBSERVATIONS

So far 4Quarters has been presented in classrooms and as an installation at SEAMUS. In observing how participants use 4Quarters, most of the visual focus is spent negotiating the phone interface and seeing how it corresponds to the shared screen projection (see Figure 5). As buttons are the main feature for making things happen (enabling and disabling tilt features are also controlled by using buttons), users tend to zone in on their own device if they are not watching the screen. But as there has yet to be any seasoned performers with 4Quarters, this may simply be the result of people getting oriented with the instrument rather than indicative of some shortcoming in design.

The current controlling parameters for this environment are fairly basic: keypresses and accelerometer-driven gestures constitute the type of physical input used to drive musical effects. In beta testing, most users tend to hold the phone like a remote control and do very little by way of physical gesture. As this is a work in progress, the eventual goal is to incorporate more sophisticated features and algorithms to help the user experience become truly visceral and physical, with rich expressive possibilities.

Additionally, the project must be streamlined to accommodate a broad level of people with varying abilities and exposures to music, computers, and mobile devices. At present the setup is far too thorny for the intended demographic of users. It requires a certain aptitude with networks, and TouchOSC is far from an ideal app because of the need to upload a layout. But once everything is set up, the actual use of the system is fairly intuitive, and participants have been able to navigate the functionality with little explanation. Next steps include the development of a custom iPhone app as well as a one for Android.

In spite of its limitations, perhaps the most promising aspect has come from observing students who supply their own audio files to load into 4Quarters. Rather than writing a piece for an ensemble to perform, I solicited a few students to prepare audio files for 4Quarters with only a few instructions: agreed-upon BPM and tonal center. In bringing these files into one session, a highly engaging improvisatory jam session ensued. Each participant knew how his own files were meant to interact, but the fun came in the pleasant surprises when mixing content.

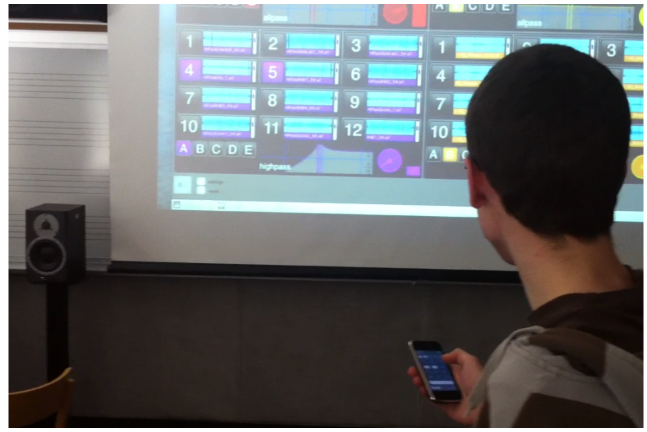

Figure 5. 4Quarters in a classroom setup at SEAMUS.

5. CONCLUSIONS

The use of mobile phones for group music making is fast becoming standard practice. This paper has introduced the concept and design of 4Quarters as a tool for improvisation and group composition. By linking a non-linear and open format for musical content to the mobile platform, and in making the control of that format decentralized, 4Quarters situates itself as a viable option for empowering musicians and non-musicians to make music creatively and collaboratively.

6. ACKNOWLEDGEMENTS

7. REFERENCES

[1] Barbosa, Á. “Displaced Soundscapes: A Survey of Network Systems for Music and Sonic Art Creation,” in *Leonardo Music Journal*, *13*, 2003, 53-59.

[2] Behrendt, F. *Handymusik: Klangkunst und ‘Mobile Devices.’* Epos Music Series, Electronic Publishing Osnabrück, 2004.

[3] Dahl, L., & Wang, G. “Sound Bounce: Physical Metaphors in Designing Mobile Music Performance,” in *Proceedings of the International Conference on New Interfaces for Musical Expression,* Sydney, Australia, 2010, pp. 178-181.

[4] Essl, G., & Rohs, M. “Interactivity for Mobile Music-Making,” *Organised Sound*, 14(02), 2009, pp. 197-207.

[5] Fabiani, M., Dubus, G., & Bresin, R. “MoodifierLive: Interactive and collaborative expressive music performance on mobile devices.” in *Proceedings of the International Conference on New Interfaces for*

Musical Expression, Oslo, Norway, 2011, pp. 116-119.

[6] Freeman, J. *Glimmer*. http://distributedmusic.gatech.edu/jason/music/music_technology/glimmer/ Posted 2004. Accessed March 16, 2012.

[7] Gaye, L., Holmquist, L. E., Behrendt, F., & Tanaka, A. "Mobile Music Technology: Report on an Emerging Community," in *Proceedings of the International Conference on New Interfaces for Musical Expression*, Paris, France, 2006, pp. 22-25.

[8] Kim-Boyle, D. "Network Musics – Play, Engagement and the Democratization of Performance," in *Proceedings of the International Conference on New Interfaces for Musical Expression*, Genova, Italy, pp. 3-8.

[9] Knowles, J., & Paek, J. *3001: Collaborative Musical Gameplay*. http://gophoneplay.com/nime/ Posted 2007. Accessed March 16, 2012.

[10] Levin, G. *An Informal Catalogue of Mobile Phone Performances, Installations and Artworks*. http://www.flong.com/texts/lists/mobile_phone/ Posted September 2001. Accessed March 14, 2012.

[11] Levin, G. *Dialtones (A Telesymphony)*. http://www.flong.com/projects/telesymphony/ Posted 2001. Accessed March 16, 2012.

[12] Miller, K. "Schizophonic Performance: Guitar Hero, Rock Band, and Virtual Virtuosity," in *Journal of the Society for American Music*, 3(04), 2009, pp. 395-429.

[13] Oh, J., Herrera, J., Bryan, N. J., Dahl, L., & Wang, G. "Evolving The Mobile Phone Orchestra," in *Proceedings of the International Conference on New Interfaces for Musical Expression*, Sydney, Australia, 2010, pp. 82-87.

[14] Schiemer, G. & Havryliv, M. "Pocket Gamelan: Tuneable trajectories for ying sources in Mandala 3 and Mandala 4," in *Proceedings of the International Conference on New Interfaces for Musical Expression*, Paris, France, 2006, pp. 37-42.

[15] Tanaka, A. "Mobile Music Making," in *Proceedings of the International Conference on New Interfaces for Musical Expression,* Hamamatsu, Japan, 2004, pp. 154-156.

[16] Tanaka, A. "Mapping Out Instruments, Affordances, and Mobiles," in *Proceedings of the International Conference on New Interfaces for Musical Expression*, Sydney, Australia, 2010, pp. 15-18.

[17] Tanaka, A., & Gemeinboeck, P. "A Framework for Spatial Interaction in Locative Media," in *Proceedings of the International Conference on New Interfaces for Musical Expression,* Paris, France, 2006, pp. 26-30.

[18] Wakin, D. "Horns Up. Bows Ready. Cellphones On." in *New York Times,* http://www.nytimes.com/2006/10/03/arts/music/03cell.htm Accessed March 16, 2012

[19] Wang, G. "Designing Smule's iPhone Ocarina," in *Proceedings of the International Conference on New Interfaces for Musical Expression,* Pittsburgh, USA, 2009, pp. 303-307.

[20] Wang, G., Essl, G., & Penttinen, H. "Do Mobile Phones Dream of Electric Orchestras?" in *Proceedings of the International Computer Music Conference,* Belfast, Ireland, 2008.

[21] Wang, G., Essl, G., & Penttinen, H. "MoPho – A Suite for a Mobile Phone Orchestra," in *Proceedings of the International Conference on New Interfaces for Musical Expression*, Genova, Italy, Paper 209. Retrieved from http://nime2008.casapaganini.org/documents/Proceedings/Performances/209.pdf

[22] Weinberg, G. "Interconnected Musical Networks: Toward a Theoretical Framework," *Computer Music Journal*, *29*(2), 2005, pp. 23-39.

[23] Weinberg, G., Beck, A., Godfrey, M., & Walk, T. "ZooZBeat : a Gesture-based Mobile Music Studio," in *Proceedings of the International Conference on New Interfaces for Musical Expression*,Pittsburgh, USA, 2009, pp. 312-315.

LAPTOP ORCHESTRA COMMUNICATION USING PUBLISH-SUBSCRIBE AND PEER-TO-PEER STRATEGIES

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Schools of Computer Science, Art, and Music

ABSTRACT

Laptop orchestras tend to use ad-hoc network-based communication, often using Open Sound Control (OSC) running over UDP. Instead, we have created laptop ensembles using a central server and a publish-subscribe protocol running over TCP. A new wide-area system, to be premiered at SLEO 2012, uses an overlay network based on peer-to-peer systems. I describe some networking options and the design decisions behind two laptop orchestra communication systems. Important issues include the use of TCP, the use of central servers, and the use of publish-subscribe. Two systems are described. One is intended for a local area network and uses a central server and a star configuration for all communications. The second system is designed for a wide-area “federation” of laptop orchestras and uses both a central server and peer-to-peer “supernodes” to achieve both ease-of-configuration and efficient communication.

1. INTRODUCTION

Network communication is the heart of laptop and distributed music performances. Although traditional musical concerns are still important, it is the digital interaction in the small and communication in the large that offer new avenues for artistic exploration [9] [10][11] [13]. With that in mind, it is worth exploring the range of possibilities for network organization and services in music performances.

Our work is motivated by practical concerns of configuring laptops for communication and making it simpler for applications (i.e. computer music compositions) to use networks. The seemingly simple problem of establishing communications is an often overlooked source of confusion and frustration. Another issue is the problem of reliable communication in a wired and possibly congested networking environment. Finally, there is the problem of getting information to the right places within a network of devices that may be changing constantly.

1.1. Establishing Network Connections

Most networked computers rely on the client-server paradigm. Network software, APIs, and protocols encourage client-server arrangements because they have a long tradition, they have been successful in many applications, they are relatively simple, and the paradigm is now well understood. Even the structure of the Internet and Internet protocols reflect a client-server mentality. For example, the modern Internet has effectively two classes of nodes. First, there are permanent “server” nodes with domain names and fixed IP addresses that can be looked up and accessed from anywhere on the Internet. Second, there are transient “client” nodes that acquire IP addresses dynamically. Domain names are not registered for these transient IP addresses, and these nodes are difficult to reach because there is no directory service for them comparable to the Domain Name System (DNS) used to reach servers. An important exception is that when a client contacts a server, the client sends a source IP address so that the server can send a response to the client.

In the early days of the Internet, nearly all nodes had domain names and fixed IP addresses, so any machine could pose as a server, and peer-to-peer networks were at least supported by DNS, allowing convenient address lookup. As the IP address space became filled and wireless networks allowed nodes to roam from one network to another, the practice of assigning a fixed IP address at a fixed node became impractical. Now, it is typical for a laptop to have wireless networking, a dynamically assigned IP address, and no DNS entry that would allow an IP address lookup by name.

As a consequence, establishing connections between laptops, especially a wide-area collection of them, is cumbersome. Often, out-of-band mechanisms such as a chat session or a phone call are used to exchange IP addresses, which are manually typed into an application before connections can be established. One of our goals, therefore, is to consider how networks of machines can be configured and connected in a more reliable and convenient manner.

1.2. Reliable Communication

The Internet is designed to tolerate network failures that range from losing individual messages to losing entire networks. The simplest communication pattern is the “datagram” where a packet of data is sent from source to destination with “best effort” delivery, the basic service of the Internet. This protocol, called UDP (User Datagram Protocol), is ideal for some musical tasks. When a program

sends a UDP message, the message is delivered as soon as possible, the entire message travels as a unit (the receiver either receives the entire message at once or receives nothing), and there is no connection to set up before sending a message.

On the other hand, UDP does not guarantee that messages will be received. This is not usually a problem if the data consists of sensor data that is updated many times per second. If a datagram is dropped, a new up-to-date value will follow shortly. In other situations, such as MIDI note-off data, chat messages, or any one-time event notification, a lost message can be disastrous in a live performance.

The main alternative to UDP is TCP (Transmission Control Protocol), which offers the abstraction of a reliable byte-stream.[1] The advantage of TCP is that it is reliable: the sender pushes bytes into one end of a TCP connection and the exact same sequence emerges from the other end. This means that commands are never lost (unless the entire connection is dropped, but the receiver will be notified if this happens). Although TCP delivers a continuous stream of bytes rather than datagrams, it is simple to send a length count ahead of each message so that the receiver can reconstruct a message sequence and never act upon a partial message.

TCP is often thought to add unwanted overhead and latency. The overhead of TCP consists of a small amount of computation, a few extra fields in message headers, and some extra buffers for messages. TCP packets are acknowledged by sending messages from the data receiver back to the sender, which adds some network bandwidth. At least on a modern laptop and a network that is not saturated, this overhead seems negligible.

Latency above and beyond the ordinary network latency experienced by UDP has two possible sources in TCP. First, TCP attempts to use the network efficiently by waiting for a full packet of data before sending anything. This can cause small messages (typical in interactive music systems) to wait for a timeout before being sent. Setting the TCP_NOWAIT option on the TCP socket can disable this behavior.

A more important concern is latency due to lost packets. When a network packet is lost, there are two main recovery mechanisms, both of which introduce delay. First, the sender may send another packet. When the packet arrives, the receiver can determine from a sequence number that a packet is missing. The receiver requests a retransmission of the missing packet, which is held by the sender in a buffer. The dropped packet *and the following packet* are delayed by at least one round trip time. The following packet is delayed because bytes must be delivered in order. The second possibility is that the sender times out while waiting for an acknowledgement and retransmits the unacknowledged packet. This adds latency equal to the time-out interval, which is at least the network round-trip time, and could be several seconds.

Another possible source of latency is that when a burst of messages is to be sent, TCP flow control will limit the number of unacknowledged packets that can be sent. This is not necessarily bad, since too many packets cause congestion, and congestion is the usual reason that packets are not delivered.

Do modern networks really drop packets? One of the arguments for UDP is that local area networks are so reliable that more elaborate protocols are not necessary. This is generally true, but I have experienced situations where UDP packets were dropped, probably in the local kernel, when many packets were generated at once. So there are situations on local area networks where packets are dropped. On the Internet, packets are dropped wherever there is congestion. Congestion is a natural occurrence on the Internet because bulk transfers over TCP (including movie streaming) constantly increase their transmission rates until they experience congestion. This is the mechanism TCP uses to discover the available bandwidth and to share that bandwidth fairly with other TCP connections.

To the extent that networks are reliable, TCP offers low latency delivery similar to UDP. When packets are dropped, significant latency can occur, but this may be preferable to losing the data altogether.

1.3. Publish-Subscribe Communication

Laptop orchestras can benefit from flexible communication patterns. One might want a “master” to send to all “slave” nodes, or point-to-point communication as in chat systems, or section leader to all members of a particular section. When laptops are identified by IP addresses, it can be difficult to determine where to send messages or which messages to pay attention to.

A nice solution is the Publish-Subscribe paradigm. The idea is that messages include a “topic” as well as a “payload” of data. Rather than directing messages to particular computers, processes, or ports, messages are “published” without reference to any particular reader. Readers, called “subscribers,” receive all published messages pertaining to a topic to which the subscriber has previously subscribed.

For example, topics could be “harmony” and “tempo.” A laptop application that generates tones might subscribe to the “harmony” topic and use the data to constrain generated arpeggios to given harmonies. Another application might infer chords from a live stream of MIDI data and publish the chord information to the “harmony” topic. Notice that the publisher does not need to know which, if any, computers are subscribed to “harmony.” At the same time, another computer might publish changes to “tempo” that are read by subscribers that include all of the arpeggio generators as well as a set of drum pattern applications.

[1] One could also create a new protocol especially for music, but simple protocols can often be layered over UDP and complex protocols are so difficult to implement that they would have to offer substantial gains to be worth the effort.

2. RELATED WORK

Networking in general is a major topic of study in computer science [2]. A brief discussion of TCP, UDP and networking in the Aura system is discussed in [1]. Previous music networking efforts include RMCP [4] and the popular Open Sound Control (OSC) [5]. OSC is a client-server system, but by broadcasting packets to all servers, a publish-subscribe-like scheme can be implemented. A discussion of timestamped messages, latency, and jitter can be found in [6].

This paper expands upon a report on the Carnegie Mellon Laptop Orchestra [7] with a new design for a wide-area "federation" of laptop orchestras. This work was largely inspired by other systems [8][12].

3. CENTRAL SERVER SYSTEM

In 2006, my class constructed laptop orchestra software and performed a concert. The musical concept was to coordinate many performers using a lead-sheet-like structure that specified harmony and rhythm, but left details to the performers and their algorithms. Various performers were involved in controlling the dynamic generation of the lead-sheet and operating algorithmic music generation that created melodic, harmonic, and rhythmic parts constrained by lead-sheet, tempo, and style information.

To manage communication, a star configuration was used (see **Figure 1**). This has several advantages. First, for N computers, there are N-1 connections to make as opposed to $N(N\text{-}1)$ connections for a fully-connected peer-to-peer arrangement. Secondly, the Central Hub in the figure is a server and all other components are clients, so only the IP address of the hub is needed by all to establish the network connections. Third, the configuration allows computers to enter and leave the configuration freely, with very little impact on the overall operation. The connections to the Central Hub are TCP connections. In principle, computers could connect from a distance without worrying about losing packets.

3.1. Publish Subscribe

Communication in this system uses a Publish-Subscribe system. The operation is extremely simple: Clients connect to the server, which maintains a list of connected clients. When a client closes a socket, the server removes the client from the list. After connecting, clients announce topics of interest to the server, which stores these topics in the client's entry on the list. Then, clients send messages to the server with a topic. The server searches the list of clients for those subscribed to the topic and forwards the message to those clients.

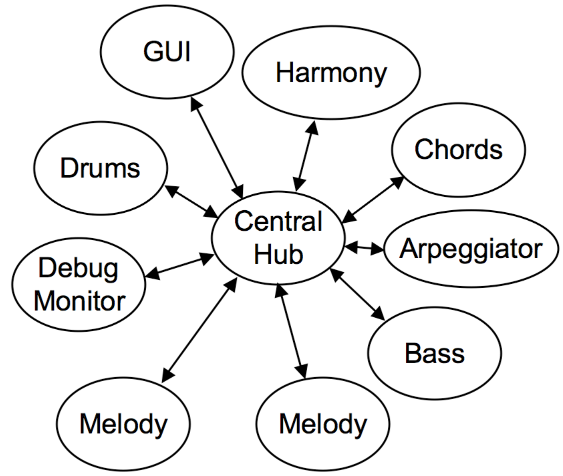

Figure 1. Organization of a laptop orchestra network.

Clients listen for incoming messages from the server. (The interaction here is not request-response as in fetching web pages via HTTP. Instead, the client and server have a fully asynchronous flow of messages.) Based on the topic of the message, the client dispatches the message to an appropriate handler. For example, "harmony" messages update a lead-sheet data structure with the chord progression for the next measure, and "chat" messages post some text into a chat window.

3.2. Time Synchronization

Because the music was tonal and rhythmic, we spent some time designing a system that could accurately synchronize measures and beats. A design goal of the system was to avoid something like MIDI clock messages that broadcast clock pulses. This would not work well because of the potential latency over TCP connections. Instead, we use a two-step process.

In the first step, we synchronize clocks between the server, which has the master clock, and all the clients. Clock synchronization is initiated by the client, which sends a clock sync message to the server. The server immediately reads its master clock and returns the time – call it G – to the client. The client measures the round-trip time of the clock sync message – call it R. If R is small, the client estimates that G was read $R/2$ seconds in the past, so the current time is estimated to be $G + R/2$. A better estimate is obtained by requesting G many times and using the value with the lowest round trip time R.

Once G is known, the client can compute the offset between the master clock and local time. Now, the global time can be estimated accurately by reading the local clock and adding the offset. This is fast and does not require another network message.

The second step for music synchronization is to express the current beat as a linear function of global time. E.g. if the tempo is 120 BPM (2 beats per second) and beat 100 occurred at time 71, then the current beat is:

$Beat = 100 + (G - 71) \times 2.$

This is easily computed locally, and if the three parameters (*beatOrigin, timeOrigin, tempo*) are sent to all computers, they will compute the same *Beat* regardless of the network latency.

3.3. Forward Synchronous Scheduling

One advantage of synchronized clocks is that network latency (or potential latency) can be somewhat avoided. Suppose that an event is to take place simultaneously in all nodes in 500ms. A simple plan is to wait 500ms and send messages to all nodes to perform the action. This will result is timing that depends upon the network delivery time.

Alternatively, we could send messages immediately to perform the action with a delay of 500ms. This would still result in event times that depend upon the network delay.

The best approach is to compute an absolute time for the actions to take place: G + 500ms, where G is the global time. Now, as long as the delivery time is less than 500ms, messages will arrive early but will be delayed until G + 500ms. Since all clocks are synchronized, the messages will be acted upon simultaneously.

We refer to this as a "forward synchronous" system [6] because it acts like a synchronous system with precise timing as long as messages can be computed and delivered early.

4. PEER-TO-PEER SYSTEM

Our new system is designed for a widely distributed performance by a "federation" of laptop orchestras. Each orchestra maintains some autonomy but follows suggestions about style, musical language, intensity, or even text instructions from a conductor. Our main concerns in this design are simple configuration and efficient reliable communication. For example, if a message is to be delivered to everyone in an orchestra that is 3000 miles away, it would be best to send one message to the orchestra and let the orchestra deliver copies of the message for each local performer. This cuts down on bandwidth and, assuming the first message makes the 3000 mile trip, cuts down on retransmission time if any member of the orchestra loses a local copy of the message, perhaps due to a wireless connection.

The second problem we address with this design is configuration. With many orchestras at long distances, it is cumbersome to exchange IP addresses. We use a central web server to register federation members, their roles, and to exchange IP addresses. Essentially, we replace DNS with our own naming and network addressing scheme, but still build upon basic TCP.

The overall network design is shown in **Figure 2**. There are actually three networks: Audio, Video, and Control. The Audio and Video networks are based on existing applications, so they will not be discussed further. The Control network is used to distribute control messages from the Conductor node to all other nodes. Each node can use a chat window to send text messages to any other node or group of nodes. In practice the Conductor may give different directions to different orchestras or even to individual orchestra members. The instructions give guidelines for improvisational "languages" such as long tones, isolated points, trills, large intervals, etc.

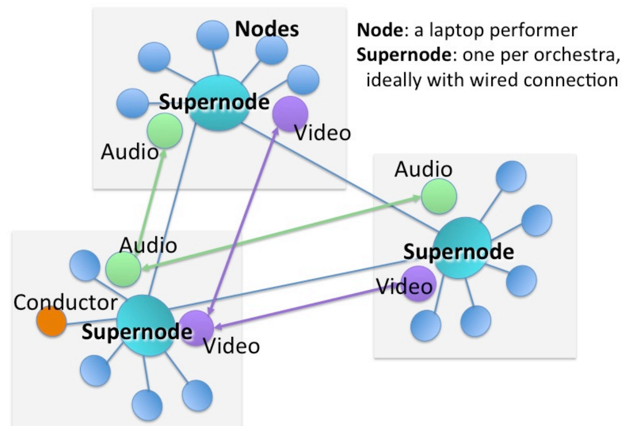

Figure 2. Federation of Laptop Orchestras Network

4.1. Nodes and Super-nodes

Based on Kazaa and Skype [14], our system uses a super-node at each orchestra site. The purpose of a super-node is to provide message routing and to take advantage of nodes with wired network connections, if any. Rather than routing messages using IP addresses, messages are sent to symbolic addresses. E.g. to reach the super-node at Carnegie Mellon, the address "/cmu" is used. A message with that address would be delivered from the source node to its super-node over a TCP connection. Super-nodes are fully connected with TCP connections, so the super-node can use a "direct" connection to "/cmu." In essence, the super-node is a router that forwards the message in the right direction. If the address were "/cmu/fred", the super-node at Carnegie Mellon would look in a local table for a local node named "fred" and forward the message to that node. The super-node configuration allows for efficient broadcasting. The address "/*" sends to all super-nodes, and "/*/*" sends to all nodes and super-nodes. "/cmu/*" sends to all nodes in the "cmu" orchestra.

4.2. Network Configuration

To configure the network, all connecting machines must have the IP address of the machine they are connecting to, and IP addresses must be associated with names, e.g. all super-nodes must know which IP address corresponds to the super-node at "cmu". This problem is handled by using

a web server. The web server allows nodes and super-nodes to register their IP addresses and associate them with (1) a federation, (2) an orchestra, (3) a role (either super-node or node), and (4) a node name (if this is a node). The web server records the information and replies with configuration information. If a node registers, the node's super-node's IP address is returned. If a super-node registers, a list of super-node orchestra names and IP addresses is returned along with a list of nodes in the super-node's orchestra.

The use of a web server allows all nodes to go to a single symbolic URL and automatically configure the network. This approach has a single point of failure (the web server), but we can use a reliable server and even provide a backup server. We also use the server for reporting performance measurements and accessing them through a browser.

4.3. Clock Synchronization

Our clock synchronization scheme is a distributed version of the one described above. Nodes synchronize to their super-node's clock, and super-nodes synchronize to a designated master. The master is the first super-node to joint the orchestra. If the master fails or becomes disconnected, the second super-node to join takes on the role of master. This protocol is simple because registration is serialized by the web server.

4.4. Publish-Subscribe

The publish-subscribe system augments messages with topics as well as addresses. We decided that explicit addresses would be useful to direct messages to the right machines, and we use topics mainly to direct messages to the right subsystem. For example, a chat subsystem can request to receive all messages with topic "chat." There are a number of subsystems, including Chat, Clock, PerformerUI, ConductorUI, and PerformanceMonitor. Subsystems register with the PublishSubscribe system to subscribe to a topic. When a message arrives for that topic, a run method is called.

4.5. Other Ideas

Rather than use TCP, it might be possible to use multiple redundant UDP packets. If packets are rarely dropped, then the chance of losing *all* copies of a packet might be low enough to be tolerable. This is the basis for forward error correction schemes often used with streaming media. If possible, packets should be delivered through different paths and at small time offsets to avoid correlated loss of multiple packets.

In our system, the control bandwidth is very low, so another way to achieve greater reliability would be to send the recent history of messages in each new packet. Using sequence numbers, the receiver could detect missed packets and extract the missed data from the recent history.

Another idea is that keeping a steady flow of messages might help lower the latency of TCP when a packet is lost. In the worst case, a packet is sent, lost, and there are no subsequent packets for several seconds. In this case, the transmitter times out waiting for an acknowledgement and retransmits. The timeout can last seconds. On the other hand, if new packets follow close behind the lost packet, the acknowledgment packets will indicate that a packet was lost, and the sender can retransmit even before the timeout. This *fast retransmit* mechanism is part of TCP. By sending at least a few short packets soon after a packet with real data, the latency of TCP might be reduced in the worst cases.

4.6. Implementation Status and Future Work

The initial design and implementation is complete and the "Federation of Laptop Orchestras" will be presented at the SLEO symposium in April, 2012. The implementation, using Java, is available as the "floctrl" project on SourceForge (sourceforge.net).

We have not yet conducted any performance measurements, but our new system is instrumented to collect data on network latency, data rates, and message counts. In the future, the super-node organization should be ideal for digitally mixing audio from nodes, mixing it to a few channels, and sending the audio to all other orchestras or to a designated "hub" for mixing and redistribution. Audio and video might use their own streams of UDP messages, but the Control network, with its reliable publish-subscribe messaging can be used to configure, control, and monitor the audio and video transmission.

5. CONCLUSIONS

The concepts in this paper are not new to networking, but it is hoped that a description of these techniques in the context of music networks will be useful to musicians and encourage others to develop designs that best suit their musical needs. The designs we have presented enable laptop orchestras to distribute information in a flexible topic-based manner. It is especially useful to decouple the addressing of messages from dynamically assigned IP addresses. It is also useful that communications and programs can continue even if some recipients of messages shut down, lose their network connections, or crash.

6. ACKNOWLEDGMENTS

I would like to thank Stephen Beck for suggesting the coordination of many laptop orchestras and working to make a performance possible. The "Federation of Laptop Orchestras" is a project of a class, Computer Music Systems and Information Processing, at Carnegie Mellon Univer-

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7. REFERENCES

[1] Dannenberg, R. and P. van de Lageweg. "A System Supporting Flexible Distributed Real-Time Music Processing," in *Proceedings of the International Computer Music Conference*, Havana, Cuba, 2001, pp. 267-270.

[2] Peterson, L. and B. Davie. *Computer Networks: A Systems Approach – 5th Ed.*. Amsterdam: Elsevier, January 2012.

[3] Fober, D. "Real-time Midi Data Flow on Ethernet and the Software Architecture of MidiShare," in *Proceedings of the 1994 International Computer Music Conference*, Aarhus, Denmark, 1994, pp. 447-50.

[4] Goto, M., R. Neyama, and Y. Muraoka. "RMCP: Remote Music Control Protocol—Design and Applications," in *Proceedings of the 1997 ICMC,* Thessaloniki, Greece, pp. 446-9.

[5] Wright, M. and A. Freed. "OpenSound Control: A New Protocol for Communicating with Sound Synthesizers," in *Proceedings of the 1997 ICMC,* Thessaloniki, Greece, pp. 101-104.

[6] Brandt, E. and R. Dannenberg. "Time in Distributed Real-Time Systems," in *Proceedings of the 1999 International Computer Music Conference,* Beijing, China, pp. 523-6.

[7] Dannenberg, R., S. Covaco, E. Ang, I. Avramovic, B. Aygun, J. Baek, E. Barndollar, D. Duterte, J. Grafton, R. Hunter, C. Jackson, U. Kurokawa, D. Makuck, T. Mierzejewski, M. Rivera, D. Torres, A. Yu. "The Carnegie Mellon Laptop Orchestra," in *Proceedings of the 2007 International Computer Music Conference, Volume II,* Copenhagen, Denmark, pp. II-340 – 343.

[8] Trueman, D., P. Cook, S. Smallwood, and G. Wang. "PLOrk: Princeton Laptop Orchestra, Year 1," in *Proceedings of the 2006 International Computer Music Conference (ICMC),* New Orleans, U.S.

[9] Smallwood, S., D. Trueman, P. Cook, and G. Wang. "Composing for Laptop Orchestra. *Computer Music Journal* **32**(1). 2008. pp. 9-25.

[10] Weinberg, G. "Interconnected Music Networks: Toward a Theoretical Framework." *Computer Music Journal* **29**(2). 2005. Pp. 23-39.

[11] Bishoff, J., R. Gold, and J. Horton. "Music for an Interactive Network of Microcomputers." *Computer Music Journal* **2**(3). 1978. pp.. 24-9.

[12] C. Burns and G. Surges. "NRCI: Software Tools for Laptop Ensemble," in *Proceedings of the 2008 International Computer Music Conference,* Belfast, UK.

[13] Gresham-Lancaster, S. "The Aesthetics and History of the Hub: The Effects of Changing Technology on Network Music," *Leonardo Music Journal* 8. 1998. pp. 39-44.

[14] S. Baset and H. Schulzrinne. "Analysis of the Skype Peer-to-Peer Internet Telephony Protocol," in *INFOCOM06*.

ALSKDJALSKDJALSKDJ:
documenting the process involved in writing a timing-accurate networked piece for a laptop ensemble

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ABSTRACT

The piece, *alskdjalskdjalskdj*, was composed during a three-year period of experimentation using a networked laptop ensemble to create flexible conducting systems and timing-accurate software instruments. During this time the piece existed in several distinct states, each of which reflected the compositional, programming, and creative concerns at that particular time. By examining the evolution of two aspects of the piece, the shared drawing environment and the pulse-based software instrument, this paper charts the process of the piece through these various stages, highlighting the different approaches to programming and the resulting changes in compositional design.

1. BACKGROUND

My first experiments involved generating real-time graphical scores for a group of improvising acoustic performers as part of a graduate seminar on improvisation and alternative performance spaces. In the final performance, musicians were spread out over various indoor and outdoor spaces, and ran an application on their laptops that gave them instructions on how to play in real time. These instructions came in the form of various shapes and colors drawn on their screens that were controlled by a conductor over the wireless network.

The next stage of the piece incorporated a time-accurate software instrument for generating the sounds, and was created for an undergraduate course in computer and electronic music through programming, performance, and composition at Princeton University [2]. The conducted, graphical element of this version of the piece changed to reflect the compositional issues that emerged with the addition of the new instrument. This version of the piece was also shaped by experimentation and user feedback that resulted from weekly workshop sessions with the group throughout the semester [4].

After having performed the piece several times with a professional group, Sideband, I developed a version that brings the graphical elements back into the piece in a meaningful and intuitive way. In this version, various shapes that represent sonic events move around the screen, causing notes to sound as they pass each performer's center-screen mark. The vertical position of the shape determines the pitch, and users can knock down barriers between adjacent screens, allowing their sounds to spatially migrate throughout the ensemble. While the software instrument is conceptually based on the timing system of the previous version of the piece, it uses a completely different approach to programming in order to realize it.

2. THE SHARED DRAWING ENVIRONMENT

The first version of the piece established the framework for the multi-user shared drawing environment that would ultimately be used in all subsequent versions. This environment worked by creating duplicate OpenGL drawing scenes on all of the connected computers, but only rendered a player-specific portion of the global space in each client instance. In the first version of the piece, the conductor used a host application to create and manipulate various objects in the global space, which had clearly marked zones designated for each performer (Fig. 1).

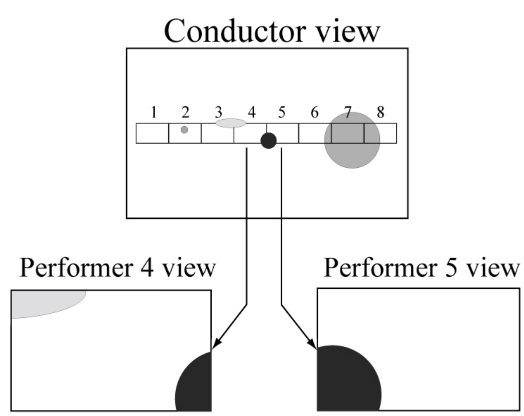

Figure 1. Example of the shared drawing environment.

The different objects represented pre-determined musical instructions, and functioned as individual elements of a larger graphical score. The performers ran a client application that revealed only their designated area of the global space. As the conductor manipulated and moved various objects in and out of the performers' individual

views, he could effectively pass musical gesture around the ensemble.

As the particular state of an object, such as its shape type, size, color, rotational speed, and screen position provided the graphical cues to the performers, it was important that the conductor be able to easily control several of the variables at the same time in order to create more complicated gestures. To achieve this, the conductor used a Wacom tablet as a multi-dimensional real-time input device and premade automation data. By holding down one of the number keys to select a specific object, the conductor could control the object's size, position, and color using the tablet's pen pressure, x/y position, and pen tilt values. The gestures that were generated could be recorded and played back at any point in the performance, or saved to use in subsequent performances.

As the number of parameters increased to reflect the greater degree of control over the desired conducted gesture, I began experimenting with incorporating a simple physics model that could control the objects in a more autonomous way. In this new environment, the conductor had control over parameters such as an object's velocity, coefficient of drag, and mass, and could set the overall system's gravity and control of collisions. The drawing aspect of the program was thus ported from Max/MSP/Jitter to Java, as that platform's text-based programming environment and its direct communication with OpenGL was better suited for these types of calculations. The physics model ran on the conductor's server application, which sent out the relevant drawing commands to the rest of the ensemble. At any point in the performance, the conductor was still able to manually control any individual object, overriding whatever physics model was currently active.

The addition of the networked software instrument in the next stage of the piece greatly altered the role of the shared drawing environment. The musical parameters that the drawn objects communicated to the group of improvisers were either no longer applicable to the new instrument, or could be controlled directly by the conductor over the network. As a result, the drawing environment was rewritten to communicate performance instructions more explicitly in the form of text that was drawn on the performer's screens. The graphical aspect of the drawing environment was limited to the ability to change the color and brightness of individual performer's screens. While the framework of the shared drawing environment was kept in place to render the text-based instructions and differentiate between individual performers, it was no longer used to draw individual objects and therefore no longer functioned as a graphical score. Instead, as the piece was ultimately performed in very low light, the glow that reflected back onto the performer's faces as their screens changed color provided a dramatic visual component to the performance (Fig. 2).

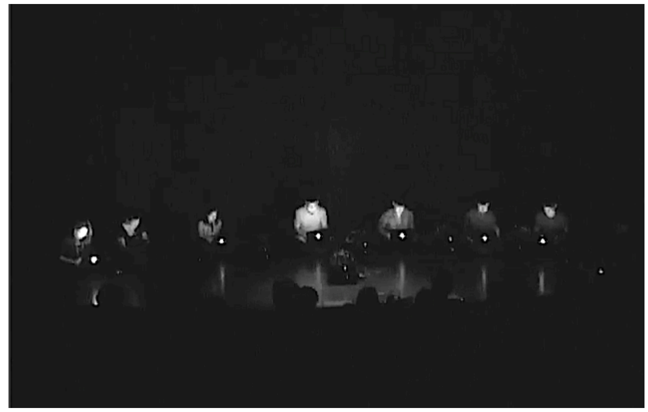

Figure 2. A performance of *alskdjalskdj* in low light.

The most recent version of the piece brought together the underlying shared drawing environment, the physics-based object models, and the software instrument in a meaningful and musically expressive way. The underlying java code was once again rewritten so that drawn objects would now trigger actual sonic events, and could be created and manipulated not only by the conductor, but by the performer themselves. Performers also had control over the boundary functions, allowing the objects that they created to move beyond their own screens and generate sounds on other performer's computers.

The first two versions of the piece used a centralized server/client architecture to control the shared drawing context. This method was well suited for the unidirectional mode of communication that existed between the conductor and performers, as the conductor generated all of the control data, the client application simply received this information over the network and translated it into the appropriate drawing commands. The initial physics model also functioned in this capacity, with the conductor machine running the model and then broadcasting the resulting data to the rest of the ensemble over the network. The final version of the piece, however, used a more distributed control of the drawing context, which effectively turned each performer into a conductor. When a performer created an object on their laptop, the object was also created in the global scene that was running on all of the laptops connected in the network. As a result, each performer application calculated the physics model as well as generating the resulting drawn graphics. The conductor and performers thus ran the exact same underlying code, but used different interfaces to determine what parameters they had control over.

3. THE INSTRUMENT

I wanted to establish a rhythmic language for this piece that could quickly alternate between precise ensemble playing and a more diffused or indeterminate hocketed sound. To achieve this, I created a software instrument that generates looping rhythmic patterns using sampled instruments triggered by performers keystrokes. When a key is pressed, the instrument initiates a repeating pulse of notes that correspond to that particular keystroke. The performer can create complex ostinato patterns by initiating multiple pulses of varying frequency and scale degree. The performer sets the rate of each pulse relative to a conductor-determined base tempo, and then decides when to trigger the pulse within the overall looping texture, effectively determining the phase. Individual pulses can then be manually resynced or turned off, either by the performers themselves or by the conductor. By sending networked controller data routed directly to the software instrument, the conductor also controls the overall tempo, the type of pitch mapping, the key, and the level of the audio effects.

Due to the wide range of musical backgrounds in the group of undergraduates and the improvisatory nature of the piece, I decided not to describe the ostinato patterns using traditional musical notation. Instead, performers received instructions on how to construct their patterns from the conductor in real-time. These instructions came in the form of a "number of voices" parameter that was displayed on their screens and dictated how many note pulses should be sounding at a given time, and other text-based performance instructions such as "listen for a gap in the overall ensemble sound, and try to place a new pulse there". The changing color of their screens indicated what sample bank they should be playing. The sample banks included prepared piano, acoustic guitar, hammer dulcimer, vibraphone, glockenspiel, and an electronic percussion set.

In this stage of the piece, controlling the pulses of notes remotely effectively meant simulating a performer's keystroke. The conductor could turn on or off any individual pulse by sending the corresponding note on, off, or sync keystrokes to a player in the ensemble. This facilitated a form of improvisation in which the conductor was able to set the entire ensemble to a uniform rhythmic pattern, for example by syncing all of their pulses at the same time, and then give them instructions on how to deviate from it either by re-syncing their pulses or by adding new ones. This achieved the desired range of rhythmic language in this piece, and also allowed individual performers to shape the sound of the ensemble in an intuitive way, regardless of their musical background.

After receiving feedback from the ensemble about their desire to be able to shape the sound of the group as a whole in other ways, I added in the ability to save, recall, and retrigger entire ostinato patterns, as well as the ability to share them with each other over the network. With a single keystroke, a performer was now able to retrigger the exact sequence of pulses they had entered, or bring back a multi-pulse sequence they had played earlier in the performance. A graphical interface indicated when a player had shared a pattern, and performers could then choose to adopt that pattern, playing it back unchanged or altering it in various ways. Experimentation with the ensemble also led to implementing a sub-grouping function, which enabled the conductor to send messages or control data to any subset of the ensemble.

The most recent version of the piece brought together the physics-based drawing model and the software instrument, establishing a meaningful correlation between the visual and sonic components. In this version, the repeating pulses of notes were represented graphically by moving objects bounded within a certain area (Fig. 3). The individual object's velocity, vertical height on the screen, and radius determined that pulse's rate, scale degree, and octave. As the objects crossed the center of the screen, they generated note-on messages, which Max routed to the software sampler. By giving the objects different y velocities, the performers were now able to create simple melodies with their pulses in a way that was not possible with the pervious system. Similarly, as the drawing context was exactly mirrored in each instance, the performers could remove the boundaries between adjacent screens and allow their pulses to migrate around the ensemble. This gave them another way to interact with the ensemble as a whole, and to sculpt their sound spatially in a way that was not possible with the previous version.

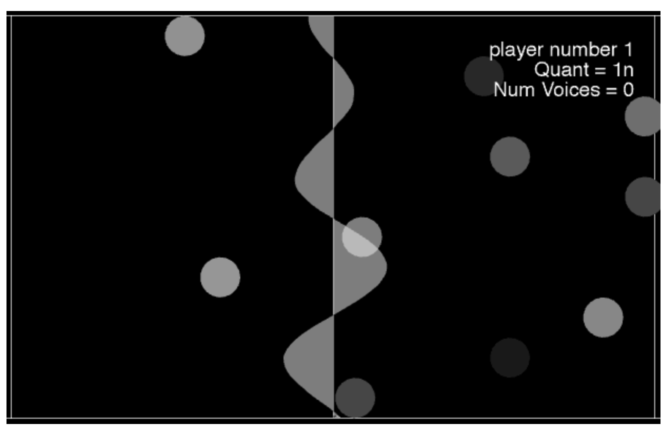

Figure 3. A snapshot of the graphical representation of an ostinato pattern.

Whereas the previous version of the software instrument used a timing system driven by Max/MSP's own scheduler, the note-on messages of the physics-based model were generated within Java using a separate scheduler thread, ensuring that the timing of the note pulses were not affected by the rendering frame-rate.

4. CONCLUSIONS

As with most pieces written for the laptop ensemble, the process of creating *alskjdlaksjdlkajsd* involved aspects of instrument design as well as more conventional compositional concerns [2, 3]. With the addition of network connectivity, this process also incorporated establishing novel means of communication, both on a technological and a musical level. These factors interacted with each other in a complex system of mutual influence and feedback, as a particular compositional idea was inevitably altered by the technology used to realize it. Feedback from performers also played an important role in the development process, providing valuable insight into the effectiveness of the various types of communication.

The changing role of the graphics during the piece's development represented one clear manifestation of the mutual influence and feedback that existed between compositional approach, instrument design, and the various modes of communication. The shared drawing environment was initially conceived of as a way for a conductor to orchestrate an improvising ensemble in real time by functioning as an ensemble-wide graphical score. New modes of communication within the ensemble that were established with the addition of the networked instrument in turn shifted the role of the graphics to a more practical means of delivering performance instructions. Finally, by attaching the physics-based drawing model to the pulse-based software instrument, the role of the graphics changed once again towards a more representative and performative type of functionality.

One important theme that emerged during the development of this piece was the changing role of the conductor, which was manifest in a gradual shift in control away from the conductor towards the individual performer. Initially, the conductor used the technology to control the drawn environment, building on the conceptual model of gesture-based scored improvisation that was developed by musicians like John Zorn, Butch Morris, and Frank Zappa in the later part of the twentieth century [1]. As the programming evolved to incorporate autonomous control of the graphical elements, various aspects of control were effectively taken away from the conductor, freeing him or her to focus on other aspects of the performance. Similarly, the shifting ways in which the performers were able to communicate with each other directly over the network resulted in changes in the conductor/performer dynamic. These changes subsequently lead to more interesting ways for the group to perform, establishing a type of meta-instrument that encompassed the entire ensemble. Finally, by giving the performers control of their own set of drawn objects, the line between conductor and performer that was established in the first version of the piece became increasingly blurred [3].

Each step in the piece's evolution forced a fundamental shift both in the way the underlying code that was implemented and in the ways in which the conductor and the performers functioned within the piece. A flexible approach to programming and compositional design was therefore vital to creating a successful piece within this medium, as it allowed the piece to transcend any singular technological aspect or innovation. For this reason, *aslkdjalskjdalksjd* will undoubtedly continue to evolve and redefine itself in the future.

5. REFERENCES

[1] Brackett, John. "Some Notes on John Zorn's Cobra", in *American Music*, Vol. 28, no. 1 (2010): 44-75

[2] Lansky, Paul. "A View From the Bus: When Machines Make Music", in *Perspectives of New Music* vol. 28/2, (Summer 1990)

[3] Smallwood, Scott; Trueman, Dan; Wang, Ge; Cook, Perry. "Composing for Laptop Orchestra," *Computer Music Journal* Spring 2008, Vol. 32, No. 1: 9–25.

[4] Trueman, D. "Clapping Machine Music Variations: a composition for acoustic/laptop ensemble" in *Proceedings of the International Computer Music Conference (ICMC),* New York City, June 1–5, 2010.

[5] Trueman, D. "Why a Laptop Orchestra?" in *Organised Sound* 12:2, August 2007.

COMPOSING FOR NETWORKS

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ABSTRACT

Debuting in 1999, Quintet.net has grown from a networked multi-timbral sampler with a simple real-time notation engine into a full-blown multimedia environment sporting numerous features such as spatialized audio engines, real-time composition and notation, video processing and sophisticated mapping of control and sensor data—while staying true to its original concept: a quintet on the Net under the control of a conductor.

Being one of the very first environments for telematic music performance, countless pieces have been realized by more than two dozens composers and multimedia artists. My presentation will give an overview of the first Internet performances at the turn of the millennium as well as the gradual shift towards local network music performance spawning the foundation of the European Bridges Ensemble in 2005. In 2007, I went back to including acoustic musicians in the mix of musicians and started to focus on networks of sight-reading classically trained performers reacting to scores generated on the fly, as exemplified in my pieces Ivresse '84 and Schwer...unheimlich schwer.

Two major multi-national projects have given us—the European Bridges Ensemble and the Hamburg Hochschule für Musik und Theater—the opportunity to refine the environment: The Hungarian-German Bipolar project as well as the CO-ME-DI-A project funded by the European commission. Within the framework of these projects some very useful tools facilitating network music performance have been developed. CO-ME-DI-A also focused on philosophical questions of making music on the Net/in networks as well as on technical questions concerning the standardization of network music performance.

I will conclude my presentation with the a discussion of the role of the participants in NMP and debate whether the hierarchical division of labor, which was typical for the orchestras of the 19th Century, has indeed made way to a more democratic, flat hierarchy of independent "proformers" (producer/performer).

1. INTRODUCTION

inspiration for composers) I have mused about the development of digital music as a co-evolution of musical and technical means spurred by the creation of the first digital computers in the 1940's [[1]]. While something analogous could probably be said about any music instrument, from bone flutes to the Moog synthesizer, some consider calling a computer network a musical instrument somewhat of a stretch. Yet, as soon as networkable computers became available at an affordable price, musicians have at once begun to explore the sonic and social possibilities of such meta-instruments [[2]].

Overcoming one's physical limitations, creating a remote presence, connecting minds and sounds over long distances was a strong motivation which made musicians first turn to telephone and satellite lines before leveraging the power of the Internet (the potential of making connections ultimately also motivated NASA to include the Golden Record in their Voyager space craft). Jérôme Joy's NMSAT timeline reflects the exponentially increasing number of networked music events that have been enabled by the enormous technological advances of the past decades [[3]].

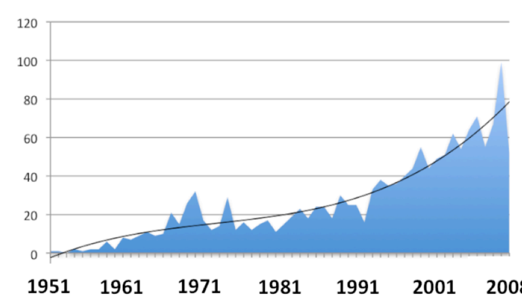

Figure 1. The NMSAT (Networked Music and Sound Art Timeline) by Jérôme Joy shows an exponential increase of related events.

When I started the development of Quintet.net in 1999 [[4]], I had to deal with a rather barren "technotope" mandating specific solutions in comparison to today's technological ecosystems, which in terms of bandwidth and speed seems to be only limited by the velocity of light and the non-standardization of software. In the following I shall outline how technological advances have led to the development of tools that have noticeably changed the nature of network music performance and

the advantages that local settings may still offer to us.

2. THE MODEM ERA

When the composers' collective *Musica Elettronica Viva* celebrated its 25th anniversary at Mills College in the winter of 1991/92, MEV member Richard Teitelbaum was snowed in by a blizzard and was not able to be present in person. To save the event students of the Center of Contemporary Music had worked all day to create a modem connection that would enable him to remotely play a MIDI keyboard while listening to the performance over the telephone. In October of 2000, when I directed the first Quintet.net performance (between Münster, Amsterdam, Wiesbaden, Boston and San Franscisco Bay Area), the situation had changed with the advent of Max signal processing and the OpenSoundControl objects, yet, still, 3 of the 5 players had to use dial-in connections to go online. Low bandwidth, long latency and considerable network jitter had serious implications which necessitated the adoption of a particular compositional approach which I'd like briefly outline [[6]]:

- Fear of the void (cenophobia) due to the physical absence of participants necessitates guided improvisation
- Phrase sampling to preserve rhythmic accuracy of performance
- Chat and verbal instructions as means to further guide musicians
- Visual clues by displaying MIDI notes in (near) real-time on the computer screen to facilitate interaction between players

Searching for existing compositions that would suit such conditions, I stumbled across John Cage's number pieces, constituting an ideal compositional paradigm for this kind of setting. His composition *Five*, therefore, was one of the first pieces ever realized with Quintet.net. Its 35 events can be performed by the five players at any time within the given time brackets.

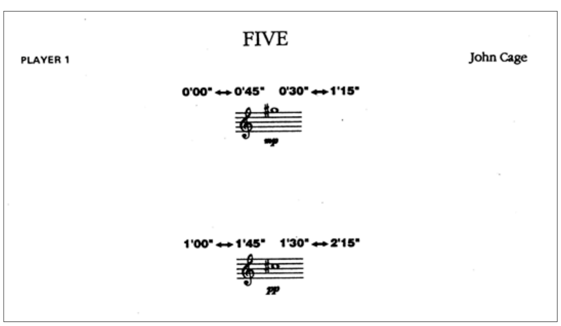

Figure 2. Notation of Five by John Cage. An ideal piece for realization in a low bandwidth, high

3. THE DSL ERA

Less than two years later, in May 2002, when Quintet.net was used in a Munich Biennale opera production, all participating locations either used Digital Subscriber Lines (DSL) or local-area networks to connect to the Internet. An attempt at using an audio/video stream of the Munich opera stage (which was connected by a 2 Mbit Internet link) was hampered by the 40 second latency of the Real broadcast[1].

The gains in terms of bandwidth, latency and jitter enabled us to use:

- Rudimentary audio/video streaming (high latency) while focusing on low latency control messages, including the use of microtones as well as note-event and video-effects processing
- Display of pre-composed scores in addition to "performance" notation

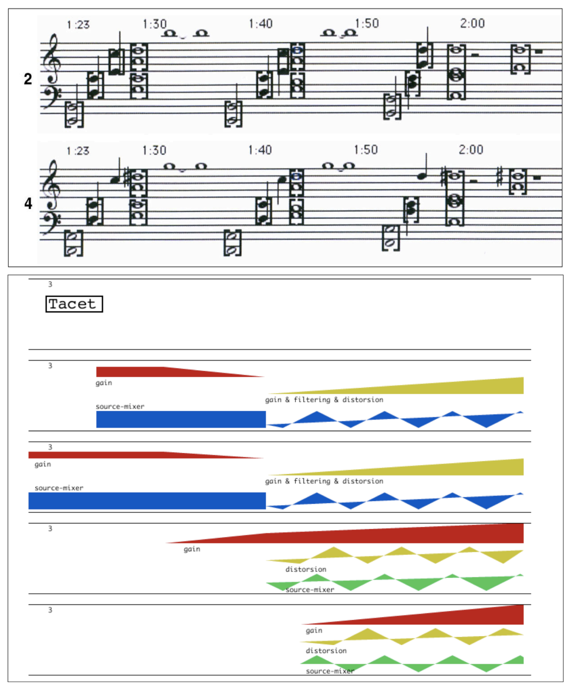

Figure 3. Notation of a section of *Bridges* composed by Andrea Szigetvári (top) and *185* by Ádám Siska (bottom). Typically, EBE pieces consist of a mix of composed and improvised elements (an approach which has also been dubbed comprovisation).

[1] As Real would charge an exorbitant $50,000 for the luxury of licensing their streaming server, broadcasts were rare and almost exclusively

4. THE INTERNET2 ERA

While in 2000, most networked music projects focused on the exchange of control data, the SoundWire group at CCRMA group started to explore the possibility of using the Internet2 to stream uncompressed audio with very low latency between distant locations [[7]]. This culminated into the development of JackTrip which, in 2005, was also used in a transatlantic concert between CCRMA (Stanford) and SARC (Belfast)[2].

In 2007, the European Culture 2007 multi-annual collaboration project CO-ME-DI-A, set out to investigate the effectiveness of existing networking technology in various scenarios, ranging from telematic concerts to synchronous robotic events in multiple locations [[8]]. Quintet.net evolved to complement these advances in audio and video streaming by integrating MaxScore, a powerful Java-based object for real-time composition and notation [[9]] as well as creating a plug-in structure for the transmission and mapping of continuous control messages, originating from sensors and standard and non-standard controllers (such as the AudioCube) [[10]].

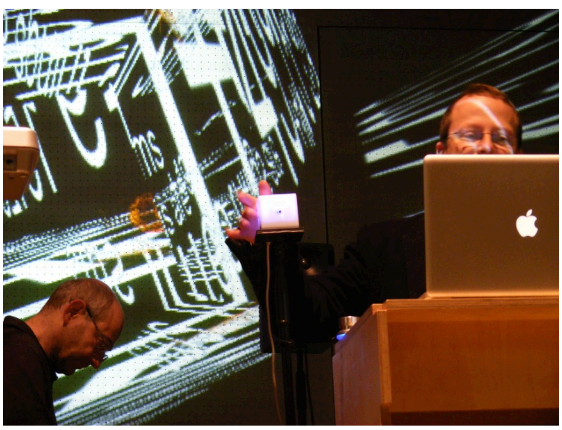

Figure 4. European Bridges Ensemble members at a rehearsal of the piece isms by Jacob Sello.

At the 2008 ICMC in Belfast, a Greek project named DIAMOUSES was presented which featured the first integrated solution for network music performance, ranging from audio and video streaming to music notation and text chat [[11]]. Subsequently, I experimented with adding low-latency audio streaming to Quintet.net via the Apple AU technology but became discouraged by the results. Latency grew as time passed, and we ended up with delays of several seconds even in local-area networks.

My conclusion from the CO-ME-DI-A project and my own experiments is that, currently, it's not advisable to create integrated systems. Even if a well-endowed group or company took on such a feat, the commitment would be enormous and probably, in the long run, not worthwhile.
Instead, as it was practiced in most projects I participated in, it is preferable to combine various specialized software applications, granted that these systems have to be tuned before every single concert.

In terms of compositional preferences, academic Gigabit networks leave very little to be desired. As long as distances don't exceed 2000 km, latencies typically stay below the acceptable threshold for "playing on the beat", as it was the case during the three-day CO-ME-DI-A showcase event in the fall of 2010.
And even at intercontinental distances, there are a sufficient number of musical styles that tolerate higher latencies. Mission accomplished—so it seems.

Figure 5. The stage at SARC, Belfast during the three-day CO-ME-DI-A showcase event in November of 2010. Two more screens on the sides showed the remote audiences.

5. GOING LOCAL

In 2005, I co-founded the European Bridges Ensemble (EBE) consisting of 5 electronic musicians, a video artist and a conductor. Our first concert connected five locations in Europe. Soon after we started receiving support by the German-Hungarian Bipolar project in 2006 it become apparent that we actually preferred to play in local networks with visual contact, limiting the online involvement to rehearsals and technical sessions.

Glancing at past network music performances, an interesting observation can be made: It seems that electronic musicians and laptop ensemble

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[2] In the meantime, in 2003 iChat AV and Skype became available for low-latency video streaming between two locations. Currently, multiuser applications such as the Unreal Media Server and

offered an explanation for this apparent paradox: The difficulty of trouble-shooting a local network of computers is compounded by the limitations of the multi-modal communication between distant locations, which EBE co-founder Andrea Szigetváry impressively demonstrated during her talk at the 2010 Music in the Global Village symposium in Pécs, Hungary. Local performances also offer more possibilities to explore choreographies of gestural and spatial movements of performance by integrating novel controllers and diffusion systems.

In 2007, I turned my attention to real-time composition and notation, becoming increasingly interested in involving classically trained musicians with good sight-reading skills. In Ivresse ’84 (2007) I contrasted four laptop performers with a violin. The music consists of a real-time re-composition of John Cage’s first Freeman etude, to be performed by a violinist, accompanied by the laptop players doing a guided improvisation with audio samples taken from the violinist’s recording of the very same piece. The formal and temporal development of the piece was controlled by myself using a Lemur touch interface, allowing me to advance to the next section whenever it seemed appropriate [[10]].

Figure 6. Violinist János Négyesy preparing for a rehearsal of Ivresse ’84 by Georg Hajdu.

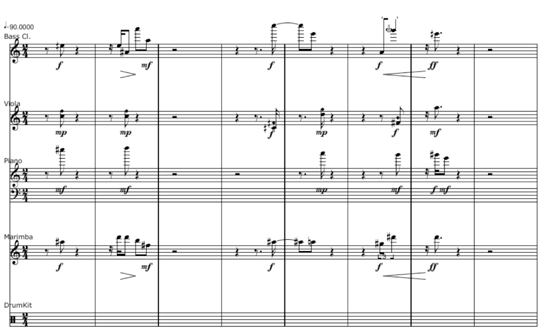

Figure 7. Real-time composition, notation and arrangement in Schwer...unheimlich schwer.

In Schwer...unheimlich schwer (2009, rev. 2011), a piece on German Red Army Faction member Ulrike Meinhof, I exclusively used four sight-reading musicians on acoustic instruments reacting to the notation as it unfolded. These situations posed new technical challenges that had to be met: score extraction and orchestration in real-time as the original compositional material was abstract and had to be adapted to the ranges and playing techniques of the instruments on the fly.

6. THE ALWAYS-ON ERA

In 2008, we did yet another adaptation of a piece by John Cage, Radio Music from 1956. In his original piece, 1 to 8 radio operators dial certain frequencies on the long-wave band within the six minutes of playing time. In my adaptation the radio stations were replaced by 15 podcasts created by the EBE members and randomly distributed on a simulated frequency band. The participants use rotary controllers to move the five cursors of the virtual radio.

Since Radio Music would lend itself perfectly to a realization on today’s *always-on* mobile devices powered by iOS or Android, I’m planning to eventually create a version for the “transistor radios of our times”.

Figure 8. Virtual radio with five dials and cursors used in Georg Hajdu’s adaptation of Radio Music. Design by Stewart Collinson.

The use of Podcasts, to be created by the players of Radio Music also reflects the new roles that the practitioners of networked music have taken on. While we still employ a conductor, my role is no more that of a benevolent dictator of acoustic ensemble, but rather of a coordinator within a flat hierarchy. The players, in contrasts, have become “proformers” (producer/performer) by providing their own content. Such roles and questions of authorship have been studied by Pedro Rebelo and Franziska Schroeder under the heading of *network topologies* [[12]].

On his 100th anniversary Cage remains a point of reference who more than any other composer of the 20th century has developed compositional strategies

recently been challenged by large corporations under the pretext of intellectual property rights [[13]].

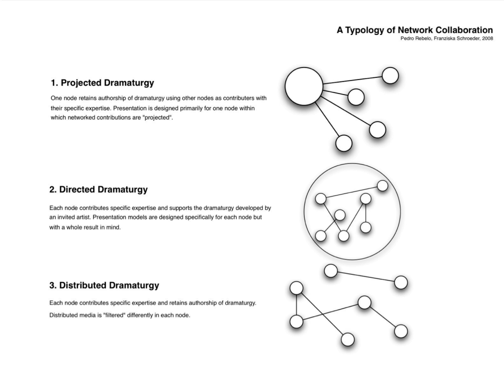

Figure 9. Network dramaturgies by Rebelo and Schroeder.

7. REFERENCES

[1] Hajdu, G. (2005): Der Computer als Inspirationsquelle für Komponisten", In B. Enders (Ed.), Mathematische Musik - musikalische Mathematik. Saarbrücken: Pfau Verlag.

[2] http://crossfade.walkerart.org/brownbischoff/introduction_main.html (retrieved on March 23, 2012)

[3] http://locusonus.org/w/?page=NMSAT (accessed on March 23, 2012)

[4] Hajdu, G. 2003. Quintet.net—Präliminarien zu einer vernetzten, interaktiven Echtzeitkompositionsumgebung," in: Bernd Enders and Joachim Stange-Elbe, eds., Global Village—Global Brain—Global Music. Universitätsverlag Rasch, Osnabrück.

[5] McLuhan, M. (1964): Understanding Media. New York: Mentor

[6] Hajdu, G. (2005). Quintet.net: An environment for composing and performing music on the Internet. Leonardo Journal 38(1).

[7] Chafe, C., Wilson, S., Leistikow, R., Chisholm, D., Scavone, G., "A Simplified Approach to High Quality Music and Sound Over IP." Proc. COSTG6 Conference on Digital Audio Effects (DAFx-00), Verona, 2000.

[8] http://www.comedia.eu.org/wordpress/ (accessed on March 23, 2012)

[9] Georg Hajdu & Nick Didkovsky. "On the evolution of music notation in network music environments". *Contemporary Music Review 28*, 4/5, pp. 395 – 407

[10] Georg Hajdu, Kai Niggemann, Ádám Siska & Andrea Szigetvári. "Notation in the Context of Quintet.net Projects". *Contemporary Music Review*, *29*, 1, pp. 39 - 53

[11] Akoumianakis D., Vellis G., Milolidakis I., Kotsalis D. & Alexandraki, C. (2008). Distributed collective practices in collaborative music performance. Proceedings of the 3rd ACM International Conference on Digital Interactive Media in Entertainment and Arts (DIMEA 2008).

[12] Rebelo, Pedro (2009) "Dramaturgy in the Network," Contemporary Music Review 28, no. 4 (2009): 387.

[13] http://en.wikipedia.org/wiki/Stop_Online_Piracy_Act (accessed on March 23, 2012)

SOUND PONG: AN INTERACTIVE EXPLORATION OF SONIC SPACE

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ABSTRACT

Sound Pong is an electronic ensemble composition for four performers using four Wii-motes and four pairs of Rec-Specs. The eight-channel work takes an historical look at the gaming experience through the use of modern controllers set inside a classic 8-bit aesthetic. Similar to the early video game *Pong*, or Robert Rauschenberg's *Open Score*, an object is hit between players from in and around a dictated space. The sound field outlines the audience space and, by placing the performers within this space, helps to fuel audience interaction. A game-like interface projects onto the front wall, fusing both audience and performer spaces together, while simultaneously augmenting the audience's interactive sensory experience.

1. INTRODUCTION

Since the establishment of multi-channel audio, composers and artists have looked at controlling the location of sounds in space. Pierre Henry developed the *pupitre d'espace* for the dissemination of sounds via induction coils, and Karlheiz Stockhausen used a rotating amplifier to distribute sounds for the performance of *Gesang der Jünglinge*.[1] In Rauschenberg's *Open Score*, performers volleyed sounds in space by using FM radio signals emitted from transmitters set in tennis rackets.[2] Rauschenberg's work applied existing metaphors and pre-established rules; however, the outcome of the work was a collaboration between technology and performers, existing with an element of indeterminate chance.

The use of electronics and the computer for "aesthetical expression" appears in early works by Frieder Nake and Manfred Mohr, both of whom utilize the computer to draw repetitive patterns that following a set of parameters with a degree of randomness.[3] The development of the GROOVE system at Bell Labs in 1968, extended continuous control of musical parameters to human touch, and Maxwell Ghent's *Phosphones* (1971) brought performers, music, and technology together.[1] The development of *Tennis For Two* (1958), and later the iconic *Pong* (1972), displayed visuals moving throughout virtual space in real-time, controlled by the interactions of users.[4] The video game propels ideas about controlling visuals over time through user input. Since the release of *Pong,* the gaming experience has evolved from single player arcade games to the home gaming console to online play with millions of others [5]. The re-appropriation of devices and video games has become a popular theme among artists, in particular Mary Flanagan, Joseph DeLappe, and Cory Arcangel. Arcangel regularly hacks old NES games for installation art.[6] The Nintendo Wii gaming system, introduced in 2006, bases a majority of its interactive games on simulating sports' gestures. Re-appropriating the Wii-mote as a musical controller for *Sound Pong* emblematically enforces the gaming experience and the use of 8-bit culture, for which the Nintendo (NES) first became popular.[7] *Sound Pong* combines early sound distribution ideas with the interactive nature of performance through the visual aesthetic of classic computer games. This compositional approach merges various disciplines and cultures into a cohesive work that encourages audience participation and simultaneously challenges traditional musical conventions.

Underlying musical structures frame *Sound Pong*; however, like Rauschenberg's *Open Score*, the performance is a "formal dance improvisation."[8] *Sound Pong* shifts away from traditional concert hall music through both performance art concepts and popular cultural metaphors. The performance challenges conventions of concert performance by using gestures of sports and the language of gaming experience to help build its structure. Players and observers engage in a real-time interactive work that employs a simple visual confirmation display to augment the sound experience.

2. CONCEPT & PROGRAMMING CHOICES

Our initial concept was to translate a virtual, moving ball into a controller of sound distribution. Looking into programming solutions, we found a simple bouncing ball example via Processing[1], which could serve as an algorithmic model for our virtual ball.[9] Using a moving ball as a sound controller was also a performance concept, where multiple performers could play with and pass

[1]Processing is an open-source programming language and programming environment used in multiple disciplines including education, animation, and interactive installations. More can be found online at http://processing.org

sounds around inside a given space. In thinking about volleying sound, we looked to Nintendo Wii-motes as a performance instrument since the controller enforced our performance ideas, and the ease of routing Wii-mote data to the computer via OSCulator[2], the data stability of the Wii-motes, and the wireless connection of multiples Wii-motes to a single computer, created a stable performance solution.

We decided early on to use Kyma[3] for our audio processing, and in order to manage the number of software programs used in the composition, we chose to use Max/MSP[4] for our data hub, as we could manipulate both Wii-mote data and the virtual ball code within one application. Because we collected Wii-mote data via OSCulator, we decided to also use OSCulator to send data inside Max to/from Kyma with 'udpsend' and 'udpreceive' objects.

3. MAPPING DATA

3.1. Program Translation and Basic Control

First, we translated the bouncing ball Processing code to Max. Using 'pictslider', 'value', and 'if' objects, we were able to visualize the code in a short amount of time. Bouncing a ball within a confined space inside Max also gave us vector information, (x,y) coordinates, which we could send to Kyma for controlling the distribution of sounds. Only after basic control of the ball motion and sound distribution was established, did we begin mapping Wii-mote data as controls over the virtual ball.

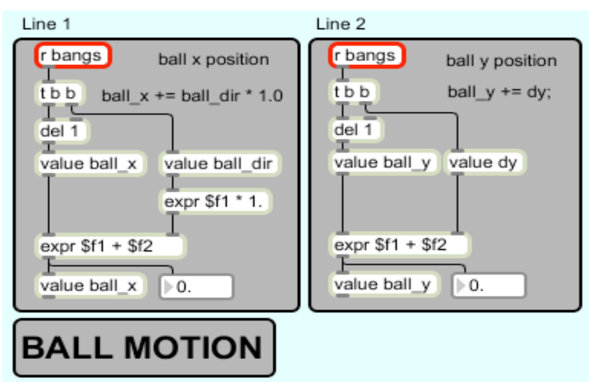

Figure 1. First two lines of Processing code translation inside Max/MSP.

3.2. Wii-mote Data

There were two types of specific information that we wanted from the Wii-motes: button triggers and continuous accelerometer data. We mapped button triggers as controlling the direction of the virtual ball (i.e. "hitting" the ball), and as triggers of sound events. Button triggers helped us to realize the piece through selection of sound banks and activating section changes.

Wii-mote accelerometer data provided support of performance gestures. We first measured the speed of arm swings as a performer 'hit' the ball. We mapped the speed measurement onto the velocity of the ball, whose position was subsequently mapped onto a sound's location in space. For example, if a performer swung quickly, the ball would move faster across the performance screen, and the related sound would subsequently move faster across the space. There was always a direct correlation between action, animated motion, and sound distribution.

3.3. Kyma

Kyma supported our two major needs: triggered sound events and continuous panning control within a multi-channel environment. As noted earlier, vectored coordinates of our virtual ball controlled the panning location of sound, which was accomplished using Open Sound Control (OSC)[5] messages and mapped to the Angle parameter inside a 'MultiChannel' Kyma sound object. To further increase the auditory experience of sounds moving throughout space, we algorithmically simulated a Doppler effect, placing the effect on all moving sounds.[6] All scaling of data was done inside of Max before sending this information over to Kyma. Sound events were triggered with MIDI, and unique sounds were assigned to each performer.

[2]OSCulator is a software application that connects hardware devices with software using various communication protocols, including Bluetooth and OSC. More can be found online at http://osculator.net

[3]Kyma is a sound design environment that supports real-time sound manipulation and multi-channel panning control. More can be found online at http://symbolicsound.com

[4]Max/MSP/Jitter is a graphical programming environment for controlling music, media, and video. More can be found online at http://cycling74.com

[5]Open Sound Control (OSC) is a stable, 32-bit protocol used for interconnecting hardware controller devices to the computer, as well as software on one or more computers using local networks. More can be found online at http://opensoundcontrol.org/

[6]It should be noted that we used Kyma Sound Library's Doppler shift effect, which uses three 'DelayWithFeedback' sound objects. We did control the hot variable, !Pan, through the location of our moving ball via OSC messages.

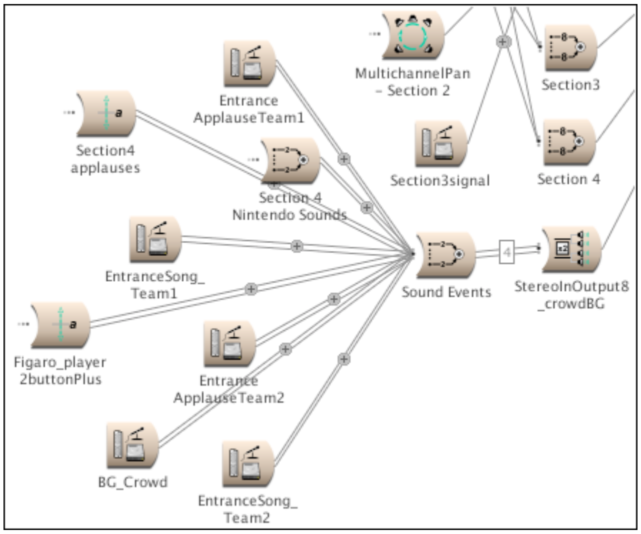

Figure 2. Kyma sound objects used in *Sound Pong*.

4. COMPOSITION PROCESS

4.1. Concept to Composition

Because our initial concept, a virtual ball controlling sound distribution, was paramount to the execution of the piece, we waited until we had a working algorithmic model before delving into the composition. From our working model of a virtual ball, to continuous control over sound distribution in our space, we moved forward with the generation of sound materials and the development of a performance that played with the language of video games and audience participation.

4.2. Sound Material

There are two types of sounds inside *Sound Pong*: sound events controlled by section changes, and performance sounds controlled by the performers. Sounds associated with events include opening music, incidental crowd noise, and 8-bit designed sounds triggered for emphasis of both musical and non-musical events.

Outside of sounds and music associated with particular events in *Sound Pong*, there are a total of seventeen performance sounds. These performance sounds consist of four banks of four sounds each, and each bank has a unique theme. Each player has control over four sounds, one in each bank of sounds. Only one bank of sounds may be accessed at any given time in order to keep related timbres together. The seventeenth performance sound is reserved for the second section of the piece, a tennis ball sound, which playfully acknowledges the aesthetic framework and historical precedence from which the piece is derived.

4.3. Scoring *Sound Pong*

The final compositional structure manifested itself through system trials, conceptual discussions, and practices with the performers. The compositional process became a collaborative effort as the technology, performers, and our ideas about performance all informed our programmatic and compositional decisions.

5. MUSICAL STRUCTURES

While *Sound Pong* enables improvisation and leaves the outcome of the piece open-ended, there is an underlying musical structure to the work. The piece is broken down into four sections, each with a distinct musical objective. The exposition of all sound material comprises the first section, where time is given for each player to reveal the sounds in each of his/her sound bank. Player One has control over the timing between the exposition of each sound bank, triggered by the Wii-mote Left and Right buttons.

The second section is a short, humorous section meant to engage the audience and recognize the inherent nature of the video game aesthetic. The virtual ball becomes an on-screen tennis ball and the performance sound changes to a realistic, tennis ball sound. The four players exchange volleys as if warming up before a real match.

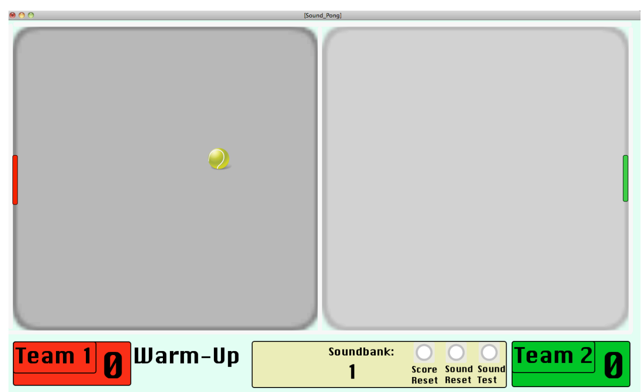

Figure 3. The performance screen projection, displaying section two.

The third section serves as a development of action, where sound banks continually change, the virtual ball is sped up to simulate tension and rise of action, and the performers are free to move about the space, disregarding normal boundaries established by volleyed sports. There is no competition here, only quick shifts in timbre, panning, and movement by performers. The third section climaxes with a triggered sound event by Player Two, a held operatic note, and cut short by an 8-bit musical phrase, which signals the introduction of the fourth section, the competitive match.

The competitive match is an indeterminate section, where the first team to get to seven points wins and also ends the piece. Not only does an 8-bit sound signal the start of the game, but the on-screen display flashes "Game On." In order to propel musical action within the fourth section, sounds are sped up after pre-determined amounts of time. Thus, scoreless action results in faster moving sounds and motions by the performers. The final match point, the concluding event of the work, is emphasized with both an 8-bit sound and a theatrical performance shift, where all four performers arrive at center stage for a final bout. The rapid action of sound and performers here brings the entire piece to its ultimate climax; not only does the outcome of this event determine the winner, but also triggers the conclusion of the piece.

Figure 4. Performers during the final match point.

Composing theatrical moments into the piece helped to accentuate the moments of rising action and demarcate section changes. By building in moments throughout the piece, for instance, the team entrances during the introduction, the dramatic end to the development section, and the center stage battle of the match point, the audience could more easily follow the performance. Both sound and visual cues were used to designate section changes, thus providing clear demarcations for all performers too.

6. AUDIENCE PARTICIPATION

Because performers and audience members were placed inside the sound field together, preconceived notions about performer-audience relationships subsided. The social and, at times, competitive nature surrounding video games enhanced ideas about engaging audience members. We made several choices to increase the sensory experience of *Sound Pong* through audience participation.

Performers were encouraged to entertain, talk, and mix with the crowd during the performance. Since performers were directly hitting sounds through, over, and around the audience who also resided inside the sound field, the piece was a shared, interactive experience.

Performers were divided into two teams identifiable by color, and corresponding colored cards were distributed randomly inside concert programs. By making the final section an indeterminate game and assigning audience members a specific team, audience members were encouraged to rout and cheer for 'their' team, building off ideas of social acceptance and belonging.

Figure 5. Audience members cheering with scorecards.

Audience members were given multiple outlets for engaging with the work. Performers moved in and around the audience. Auditory sounds moved through the entire space. A visual display of the virtual ball reinforced game aesthetics and the movement of sounds. Musical cues and an on-screen display designated section changes, informing both the performers and audience members.

Composing a non-traditional concert piece came with its challenges. For instance, non-traditional concert works and performance contexts lack an historical framework that would typically inform audience etiquette. We placed fellow composers within the audience to help suggest and reinforce "appropriate" audience behavior, easing the psychological transition of participating as an audience member inside a concert hall setting.

7. OTHER CHALLENGES

As a result of our choice to model video game aesthetics, another challenge lay in designing a system that acted similar to common and familiar cultural perceptions of video games. While the vocabulary of video games helped us dictate what should and should not be included within the system, ironing out the functions of what users expect from a system proved challenging. For instance, any one player could rapidly press the B button in order to play defense for their team. As soon as the ball crossed the court line into the opposing team's territory, the ball could immediately be returned, and it would be almost impossible to score. Coding in a trigger delay function to help the offensive team, as well as the progression of the musical movement, was crucial. Coding behaviors, like the example above, supported the performance structure and

aesthetics. For example, we programmed a natural acceleration algorithm, where the ball's motions would increase over time if no one team scored. While initially coded to ensure that a team would score and the piece could progress, the acceleration algorithm also augmented and enhanced the performance, increasing dramatic tension the longer both teams went scoreless.

8. PROGRAMMING FOR PERFORMANCE

We learned valuable lessons by working with performers of data-driven instruments and the instruments' associated technology. This section is devoted to sharing our observations and insights, in the hopes of furthering dialogue about the development of performance practice using data-driven instruments.

8.1. Tuning Instruments

Similar to an acoustic performance that tunes its instruments before playing, we incorporated a digital performance tuning practice. Since the performers of *Sound Pong* could not bow or blow on their instruments to ensure proper tuning, we included two data confirmation tests, one visual and one auditory, which could be run before each rehearsal and performance. We tested our instruments with a confirmation of data entering the computer and with a confirmation of a triggered sound, before initial stage entrance, in order to ensure a smooth start for each and every performance.

8.2. Section Leaders

Determining a section leader per team and a leader for the entire piece was important to the flow of the work. Specific control functions were assigned to each section leader, allowing us to relinquish compositional control over section changes, sound-bank selection, and triggering of climactic events. This organizational decision enabled additional players to focus solely on their performance. Moreover, by having each team leader control the performance structure functions, *Sound Pong* could potentially be realized by only two performers.

8.3. Performance Instructions & Order

Knowing that technology can falter, having a set performance structure helped us minimize the variables between rehearsals and the performance hall. A visual set of instructions ensured a consistent and familiar set-up practice, and a performance screen provided visual cues to both the performers and audience. These performance instructions serve as our documentation, so that anyone could re-stage *Sound Pong* and ensure an easy set-up.

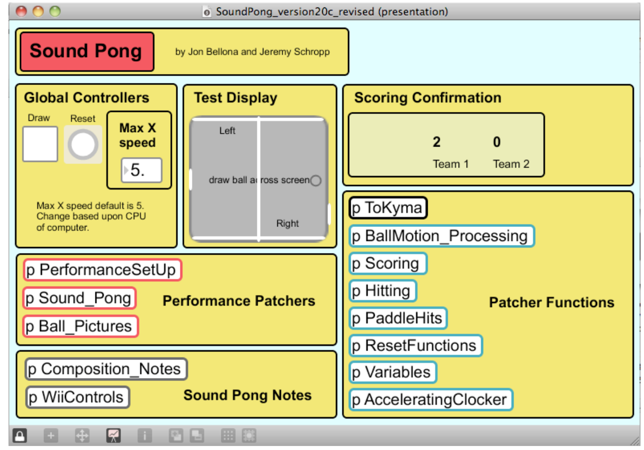

Figure 6. Opening *Sound Pong* patch, with set up instructions and necessary performance modules collected together.

8.4. Computer Technician

Composers are often their own technicians, so much so that we often tend to overlook the vital importance of this role. Setting up local area networks for Bluetooth messages; cueing section changes during a performance; even plugging in USB devices; all are technical factors related to music involving technology. Performances that involve multiple performers and potentially multiple computers may call for an established technician role. In *Sound Pong,* while both composers could adequately handle the computer setup and execution of the piece, we designated one composer as the computer technician. This role helped us to formally distribute responsibility during the rehearsals and performances, which allowed the other composer to focus on additional performance needs.

8.5. Modular Programming... Cleanly

While most who work with Max/MSP revel in the use of the presentation mode to sweep our patch cord messes under the carpet, working with human performers doesn't necessarily allow for this luxury of messy code. Since composition ideas for *Sound Pong* came through live performer rehearsals, the ability to rapidly modify functions and performance mappings during rehearsals was a must. By isolating functions into separate modules and simultaneously keeping our underlying Max patch well-commented and as clean as possible, we maximized our time with performers and accelerated our experimentation with new ideas. Both of these factors increased the time spent working with the human performance details of *Sound Pong* while concurrently increasing the trust performers had with the technology.

9. CONCLUSION

We judged the success of the performance more upon user experience than the technical execution of the piece. Since the nature of video games is less about technical virtuosity than playful competition and teamwork, we attempted to make the work naturally playful for both the performers and the audience. By layering the performer and audience space atop each other, the resulting environment allowed the audience to participate from within. The music serves the function of the game, the game environment, and helps to engage the audience in a new and interesting way.

In order to prompt further discourse as applied to the use of Nintendo Wii-motes in ensemble performance, we have created and published a mapping interface for Wii-motes online.[10] The open-source Max patch handles up to four Nintendo Wii-motes at any given time. The interface allows anyone to quickly and efficiently map Wii-mote data in a variety of creative applications, while also serving as a potential performance module. In addition, we published the *Sound Pong* source patches online for future deconstruction and discussion.[11]

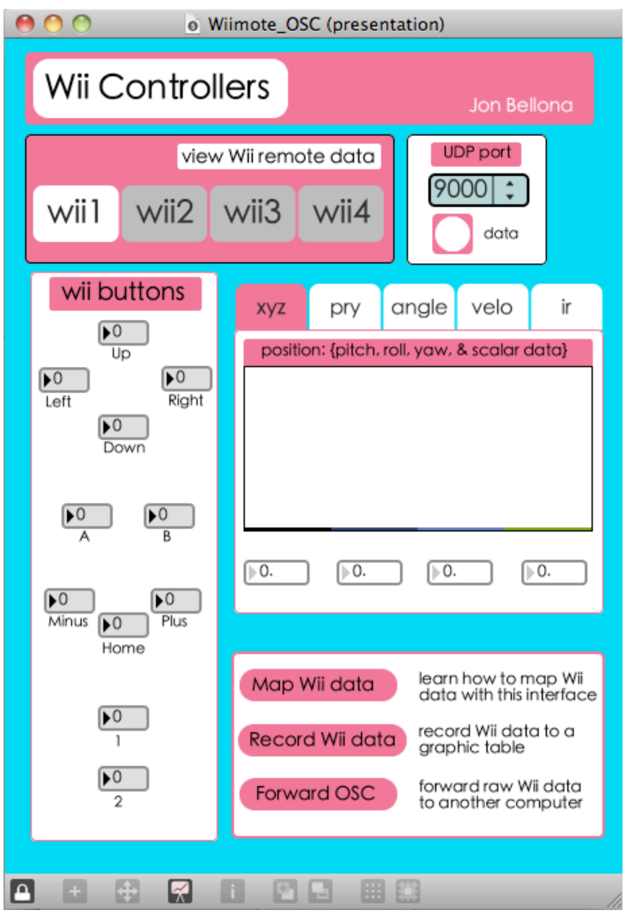

Figure 7. Our open-source Wii-mote Max interface available online, created for easy data mapping with Wiis.

10. REFERENCES

[1] Chadabe, J. *Electric Sound*. New Jersey: Prentice Hall 1997.

[2] Rauschenberg, R. *Open Score by Robert Rauschenberg, 9 Evenings: Theatre and Engineering*. New York: Experiments in Art and Technology and ARTPIX, 2007.

[3] Reas, C., McWilliams, C., LUST. *Form+Code*. New York: Princeton Architectural Press, 2010.

[4] Hunter. W. "From 'Pong' to 'Pac-man'," in DesignBoom. http://www.designboom.com/eng/education/pong.html . Last accessed March 6, 2012.

[5] Takahashi, D. "Activision Blizzard earnings: Call of Duty Elite snares 7M subscribers," in Venture Beat. http://venturebeat.com/2012/02/09/activision-blizzard-earnings-call-of-duty-elite-snares-7-million-subscribers/. Last accessed March 7, 2012.

[6] Arcangel, C. *Artist Web Site*. http://www.coryarcangel.com/things-i-made/ishotandywarhol/. Last accessed March 8, 2012.

[7] Sheff, D. *Game Over*. New York: Random House 1993.

[8] Kuo, M. "Open Score (review)," in *TDR: The Drama Review*, MIT Press, Vol. 52 no. 4 (Winter 2008), pp. 194-196.

[9] Reas, C. "Bounce," in Processing. http://processing.org/learning/topics/bounce.html. Last accessed March 10, 2012.

[10] Bellona, J. *Wii Controllers: GUI for Max/MSP*. http://deecerecords.com/projects#wiimote. Last accessed March 12, 2012.

[11] Bellona, J., Schropp, J. *Sound Pong* source patches. http://deecerecords.com/music#soundpong. Last accessed March 12, 2012.

An Approach to Collaborative Performance in a Digital Music Ensemble

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Digital music ensembles (DMEs), whose performers all use digital musical instruments (DMIs), provide the opportunity to explore social aspects of computer music performance within an ensemble setting. Physical computing can provide a framework for a digital music ensemble for many reasons. Tom Igoe describes physical computing as "an approach to learning how humans communicate through computers that starts by considering how humans express themselves physically"[4]. This statement encapsulates several key approaches to ensemble performance in a DME. Considering how humans express themselves physically refers to more than just the use of expressive gestures such as hand movements. It also includes the ways in which interact with our environment, how we position ourselves in space – whether we face each other, move closer and further away from each other – and the ways in which we use eye contact and subtle physical cues. These physical expressions are then used as the conceptual frameworks for computer-mediated forms of human communication. By focusing on performer action and placement in the physical world we are responding to the assertion of many computer musicians who feel that the correlation between visible performer gesture and sonic result is an important part of audience experience [3].

The approach to interaction proposed here consists of two parts – a mapping strategy based on the parameterization of musical elements as well as the following principles for ensemble interaction:

- The performer interface should rely on gestures which would be meaningful to the performer, fellow musicians, and audience.
- Performers should each have their own speaker, which would be positioned on stage as to localize each performer's sound in a different place. However, the performers themselves should not be tied down to a specific location.
- The performer's attention should be on their fellow performers, with interaction being the focus. There should be no central conductor, sheet music, or any kind of visual projection. The performers instruments should not require visual feedback.
- The role of the computer, and its actual physical presence, should be minimized in order to direct attention to the performers.

The most important assumption underlying all of these points is that the focus is on the interaction of the performers. This interaction is dependent upon the clear communication of the performer's intent. This communication takes the form of the performer's physical actions and the sonic result of these actions, and there must be a clear connection between action and sound. The performer must be confident in their command of their instrument; therefore, they must not be burdened with an overly complex instrument or with complex compositions.

The parameterization of musical elements is an approached to mapping used by *The Hub* in their composition *The Minister of Pitch*[1]. Parameterization is made possible through the use of digital musical instruments, in which the control interface is connected to the sound generator by

mapping strategies[5]. Intermediate mapping layers can be used to map input data to perceptual or conceptual variables, where are then mapped to synthesis paramters[6]. The implementation presented here utilizes an intermediate mapping layer which takes each performers' individual control data and integrates them based on a collaborative schema. In this schema one musician's interface is mapped to only control rhythm, while a different musician's interface is mapped to only control pitch.

In the implementation presented here there are three pairs of musicians, each performing with a Nintendo Wii Remote. In each pair one musician deals primarily with pitch and timbre material and the other musician with rhythmic material. The pitch musician uses the accelerometer in their Wiimote to draw waveforms in three dimensions. When they hold down the Wiimote's trigger button the change in acceleration in each axis is written into a wavetable. When the button is released the wavetables are read independently to generate three waveforms, which are mixed together and fed to the audio output of the computer.

The rhythm musician has a system which is oriented towards rhythmic events. The acceleration of the rhythm musician's Wiimote is read at fixed intervals. Rhythmic events are generated at each interval whose maximum amplitude and duration are derived from the accelerometer values. The data from the x-axis is used to create a percussive gated noise sound and the data from the y-axis controls the amplitude of the pitch musicians' sound.

There are three elements to the sound generated by each pair. The first element is the rhythm musician's basic percussive sound which is controlled by the x-axis of their accelerometer. This works independently from the pitch musician. The second element is the sound generated by the pitch musicians. The amplitude of the pitch musicians' sounds are determined by rhythmic events generated from the rhythm musicians' Y-axes. This is similar to the way the rhythm musicians generate their basic percussive sound – at fixed intervals the y-axis acceleration is read and this value used to determine the amplitude and duration of a rhythmic event. This rhythmic event is then used to control a gate through which the pitch musician's sound is fed. When the y-axis reading is very small or zero the pitch musician's sound is effectively silent. The third sonic element generated by each pair is the ring modulation of the pitch musician's sound by a sin wave whose amplitude is controlled by the rhythm musician's x-axis.

References

[1] Joel Chadabe. *Electric Sound: The Past and Promise of Electric Music.* Prentice Hall, New York, 1996.

[2] John Croft. Theses on liveness. *Organised Sound*, 12(01):59–66, April 2007.

[3] C. Dobrian and D. Koppelman. The "E" in NIME : Musical Expression with New Computer Interfaces. In *Proceedings of the 2006 conference on New interfaces for musical expression*, pages 277–282, Paris, France, 2006. IRCAM - Centre Pompidou in collaboration with Sorbonne University.

[4] Tom Igoe. The FAQs of Physical Computing, 2004.

[5] Eduardo Reck Miranda and Marcelo M. Wanderley. *New Digital Musical Instruments: Control And Interaction Beyond the Keyboard.* A-R Editions, Middleton, WI, 2006.

[6] M.M. Wanderley and P. Depalle. Gestural Control of Sound Synthesis. *Proceedings of the IEEE*, 92(4):632–644, April 2004.

HELOPG, LESSONS LEARNED (SO FAR)

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ABSTRACT

A review of how the Huddersfield Experimental Laptop Orchestra Postgraduate Group (HELOpg) has developed its current methodology and practice through performance and collaboration since November 2009 through a consideration of the groups chosen approach to software, hardware and sound-reinforcement strategies as developed in and informed by:

- (1) regular weekly rehearsal; (2) various performances in different settings; (3) recent recording sessions
- divergence from more common laptop orchestra approaches
- defensive methods to ensure performance capability even through device failure

Building on lessons learned (so far), HELOpg outline how their practice might inform the development of innovative models for improvisation which, whilst affording further player interaction, will not affect each individuals conceptual and sonic identity. HELOpg also introduce the SLIME System, a new methodology being developed by the group for use in networked performance.

1. HELOPG SO FAR

Since 2009 and based at the University of Huddersfield (UK), HELOpg operates as a non-unified laptop ensemble. We have deliberately chosen to avoid the development of a meta-instrument structure, opting rather to promote each individuals preferences for creative praxis. We concentrate on creating and exploring individually designed laptop interfaces which are, inevitably, devoid of a common hardware or software architecture.

At the time of its inception there was agreement that this new postgraduate laptop ensemble should reflect in its title a connection to the already established Huddersfield Experimental Laptop Orchestra (HELO). Following the precedent of object oriented programming languages, the name HELO.pg was proposed and adopted. The inclusion of a dot character in the name, however, proved to be problematic in a number of ways, not least the false identification of it by web technologies as an URL (this despite .pg at the time being unobtainable as a top level domain). A prolonged period of discussion eventually led to the group adopting its title in the present form[1].

The question of name has also been a reoccurring one because HELOpg has often been erroneously described in programme notes and gig promotion materials by text which describes the undergraduate directed ensemble. The HELOpg online documentation was, at first, found within the HELO wiki [2] which has compounded confusion. We now maintain our own site [3] with a blog which has mirrored the older wiki entries.

Given their entwined histories and location, it is unsurprising that there are a number of ways in which HELOpg is in some senses similar to HELO, particularly in its hardware and software choices [4]. In contrast to the undergraduate HELO, HELOpg has had a much smaller and more stable community over its years of activity, and we have found the band-like camaraderie developed by this to have enhanced our conceptual flexibility and fluidity within the execution of an experimental improvised performance practice. We strongly believe that this emergent methodology, embracing diversity and self-directed-ness along with collective goals, fosters an interaction based on cooperation, listening and an optimal immersed flow experience [1] leading to a greater understanding between the performers during performance.

2. ARCHITECTURE

The architectural organisation of HELOpg, in terms of software and hardware, is not fixed. Each individual performance system is subject to change, and the technologies employed to combine the group alter in accordance with that and the particular motivations of the situation. As the ensemble has an active interest in electronic experimentation, an eclectic mix of hardware and software elements are employed in practice, and different sound reinforcement techniques have been explored.

[1] HELOpg (hiːləʊpiːdʒiː)
[2] helo.ablelemon.co.uk/pg
[3] helopg.co.uk

The groups approach to organisational choices is broadly thus:

- Solutions must be low-impact by being simple and practical.
- In terms of both software and hardware the implication is for innovation to not get in the way of players regular performance setup.
- Preference is shown to software solutions that are cross-platform and promote freedom of access.

2.1. Software

Various Linux, Mac, and Windows operating systems are used with multiple softwares including, but not limited to, Chuck, Hydrogen, Max, Pd, and ReNoise. Generally, for each individual group member, small sets of custom designed or heavily tweaked code have become standard or best practice for use within performance. Live-coding is common within HELOpg performances, as are techniques which extract and utilise data from the environment in real-time. The groups potential for dynamic and varied sounds within any performance is expanded when each performer has their own customized software environment, in contrast to situations where an entire ensemble has a unified software interface.

From a pedagogical perspective, we all agree on the importance of understanding the fundamentals of the DSP-related task rather than relying on any particular software solution. The software specific methods of an individual are mostly of little collective concern: the emphasis is always upon the audible. Specific methods are often, however, of interest within the group.

2.2. Hardware

As with the software employed by the group, so the hardware is non-uniform across members, and the specifics change over time. Laptop, net-book, and touch-screen devices from Apple, IBM/Lenovo, Samsung, and others have been used, along with audio-interface and other peripherals from Novation, MOTU, M-Audio, Griffin and many others. Analog electronics, such as mixers and transducers of various types, are frequently included within individual and combined setups. HELOpg has recently experimented with approaches to some networked performance situations which has meant, in terms of hardware, the occasional inclusion of a router to facilitate a local area network. For upcoming internet-mediated performances, HELOpg will use an audio mixer to create a stereo mix which will go to the audio-interface of a desktop computer which is connected to computers elsewhere.

2.2.1. Telephones and Tablets

A discussion within the group took place recently on the appropriateness of phones and tablets for a laptop ensemble. Again, hardware choice is a matter of personal taste, and the question is highly dependent on context of use: is the phone or tablet an addition to a laptop interface? If not, then can a phone or tablet be considered as equivalent to a laptop? Can its software be (re)programmed upon the device itself? The group are still in the process of debating and exploring these possibilities.

2.3. Sound Reinforcement

2.3.1. Combined Amplification

For pragmatic purposes, and following common standard practice in various types of performance situation, HELOpg currently tends to present a single stereo mix of each performers audio output. Depending on the hardware involved in a particular environment, ensemble members often choose to utilise an alternative sub-mix as input to their own laptop (such as via aux sends from a centralised mixer) in order to process the audio output of performers.

It is often preferable to use the main stereo rig for monitoring during performance, as this way individual group members are listening to the same loudspeakers as everyone else [4]. We are each accustomed to listening to stereo mixes of music and find contributing to one such mix in real-time a natural way to perform as HELOpg. Over time, and having previously experimented with a number of other forms and methods, this method of combined amplification has become the groups favoured option.

2.3.2. Acoustic and Extended Amplification

Some early compositions and performances focused upon acoustic performance, inspired by the practise of groups such as Powerbooks Unplugged [5]. Here acoustic refers to the sole use of the laptops internal speakers to produce sound. Moving on from the acoustic, for over a year our preferred amplification was cheap guitar amps. Mono, noisy, and with narrow frequency bandwidths, these amps allowed for portability (e.g. getting to gigs on the train), durability and were inexpensive to maintain. In comparison with the acoustic approach, the use of a guitar amp extends the range of a laptop in terms of volume and low frequency response. The restrictions implied by these types of amplification models have led to novel performance implementations where the inherent bounding has became a part of the conceptual improvisational soundscape. The next step in extended amplification, for up to four performers, is available within the

[4]The physical stage layout required to achieve this also place the ensemble within the audience space allowing audience members to inspect the players screen; this behaviour is actively encouraged by the ensemble.

HISS [5] with the Bose L1mk2 system. As an extension of the guitar amp model, these Bose units provide a by comparison hi-fi solution to laptop sound reinforcement.

3. RECORDING SESSIONS

Working towards an album intended as a document of our practice at the time, each of these recording sessions captured performances of durations ranging from three to thirty-plus minutes. A number of dedicated workshop/recording sessions were also held in June 2011 for the rehearsal and recording of compositions by Julian Brooks [6].

3.1. Recording Methodology

For the recording of the improvised performance sessions, stereo outputs from each laptop instrument were routed to both a multitrack recorder and, usually, to a single stereo mix for amplification within the studio. The use of stereo sum monitoring reflects common practice employed in live performance, but the extended amplification model was revisited when recording in an eight channel surround sound studio. In both cases, the separately routed multitrack recording of individual stereo outputs allows for the relative levels in the mix to be altered post performance. Indeed, the inherent isolation between the performers in this kind of recording provides opportunity for analysis and creative post production.

For the Brooks composition recordings later in the year, sessions were conducted in the eight channel studio, monitoring without summing so that each performer had either one or two speakers for their output in isolation. Though making no obvious changes in their audition, the different methods explored have subtle implications for the groups performances and output. Choice of methodology is likely to depend on interpretation, requirements and desired outcome. As a group, HELOpg strives to support each individual in pursuing their own interests within a cooperative and supportive setting.

Possibilities for alternative recording methods have been discussed. The potential of going via amps and then microphones was rejected because the fidelity offered by direct recording of outputs is such an advantage. Other laptop ensembles are likely to adopt studio methods that reflect their own performance practice, as have HELOpg.

3.2. Mixing Methodology

Due to the documentary nature of these initial recording sessions, post production has been limited to only minor edits and subtle spectral modifications akin more to mastering, than mixing. It is however intended to undertake a studio album project to fully exploit the creative potential of the studio.

[5] http://www.thehiss.org/

[6] http://helopg.co.uk/2011/09/22/recent-text-score-recordings/

4. LIVE PERFORMANCE

Up to February 2012, HELOpg has performed at 15 public events; details and recordings of these can be found online[7].

4.1. Defensive Methods

Emergent through practice as much as by design, HELOpg has developed defensive methods to ensure performance capability. When systems are experimental, there is a definite chance of failure within performance. HELOpg nurture awareness of knowable limitations and potential hazards, so that risk taking is offset by confidence stemming from tried and tested praxis. By avoiding any centralised control, particularly within network synchronisation, no one piece of equipment failure can crash the overall system. The commodity hardware approach, combined with open source software facilities the quick exchange of hardware if disaster strikes. To this end some players maintain Git repositories, or use Dropbox[8], so that the individual software performance environment can be cloned onto another computer.

4.1.1. Interface Simplification

As argued by [3], the standard laptop interfaces of keyboard and mouse or trackpad offer a rich variety of controllers and a consistent and easily replaced performance interface. Laptop keyboards are often represented as monolithic entities. Our experience shows that the laptop keyboard as interface has many different layouts, feels, and designs. It is also something that we are all well practised upon, spending a good portion of our time interacting with computer keyboards in the everyday. Rather than representing a soft interface, we would suggest that the laptop keyboard is in fact well suited to live electronic music, and that there is generally no need for us to expand or extend our controller options. Whilst some group members have opted to augment their laptop performance interface (for example, through the use of a volume control foot pedal), these additions are designed to be easily replaced and are not viewed by all group members as necessary. HELOpg very much favour the sentic approach (see [2]) where the most complex and detailed of expression may be contained within the slightest touch.

4.2. SLIME System

Inspired by images of the League of Automatic Music Composers the SLIME System [9] links many laptops into a single

[7] http://helopg.co.uk/category/performances

[8] http://dropbox.com

[9] First used in performance at the Network Music Festival, Birmingham, January 2012.

instrument for collaborative group performance. This move toward a modal of singularity might appear as contrary to the described ethos of the group, but it stems from, and seeks to extend, the established methodology.

It has been our experience that, within the performance event and for all ensemble members, there is an occasional urge to sync/merge further into the emergent soundworld, for example by sharing various forms of real-time meta-data in addition to sub-mixing audio between laptops. To explore new territory in this direction, HELOpg have recently explored the formation of new software and strategies for ensemble performance within laptop improvisation.

While the group chooses to remain non-standardized in terms of the hardware and software of each laptop-instrument, the adoption of shared systems for integration and interaction will create new opportunities for laptop orchestra performance.

Development of the SLIME System, and the source of its acronym, began with the conception of an *interactive laptop network sound system* under the title *Metacosm*. In addition to solutions for audio routing (based on Hewitts NetMixer) and the Open Sound Control [6] protocol for communication (in terms of message structure and UDP addressing), the SLIME System aims to challenge the one-to-one performer-to-laptop ratio paradigm. Rather than viewing SLIME as a network of discrete laptop instrument systems, the idea is for hardware and software to interconnect in such a way that control data is distributed throughout the collective which one might then view as a single entity. With this objective the challenge is then to maintain a practice that aims to ensure performance capability: it cannot be that the whole structure is doomed to fall apart in the event of one machine failing.

Each perceived lack in current group practice has led to the creation of new compositional material as well as code. In this way, SLIME presents new opportunities for compositional strategy, both as a method for generating material and as a conceptual framework for musical interaction with both many-to-one and one-to-many dynamism.

The SLIME System network diagram (Figure 1) shows connections of a hypothetical laptop ensemble using the SLIME System. In this example, an extended amplification model of sound reinforcement is implied.

As the system continues to be developed, further information will be added to the HELOpg website[10]. More details about the group's recordings and performance schedule are also available on this site.

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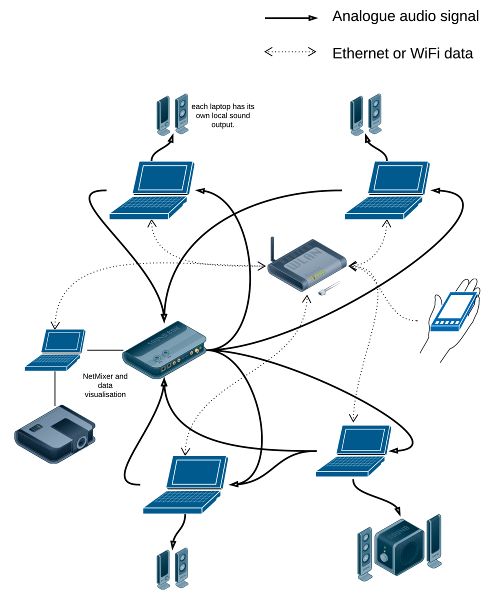
[10] http://helopg.co.uk/projects/slime-system/

Figure 1. SLIME System example



6. REFERENCES

[1] M. Csikszentmihalyi, *Flow: The psychology of optimal experience*. New York: Harper Collins, 1991.

[2] J. d'Escriván, "To sing the body electric: Instruments and effort in the performance of electronic music," *Contemporary Music Review*, vol. 25, no. 1-2, pp. 183–191, 2006.

[3] R. Fiebrink, G. Wang, and P. R. Cook, "Don't forget the laptop: Using native input capabilities for expressive musical control," New York, Jun. 2007.

[4] S. Hewitt, P. A. Tremblay, S. Freeman, and G. Booth, "HELO: the laptop ensemble as an incubator for individual laptop performance practices," New York, Jun. 2010.

[5] J. Rohrhuber, A. de Campo, R. Wieser, J. van Kampen, E. Ho, and H. Hlzl, "Purloined letters and distributed persons," in *Music in the Global Village Conference (Budapest)*, 2007.

[6] M. Wright, "Open sound control: an enabling technology for musical networking," *Organised Sound*, vol. 10, no. 3, pp. 193–200, 2005.

TOWARDS A NOMENCLATURE FOR LAPTOP ORCHESTRA WORKS BASED ON THEIR PERFORMANCE AND CONTROL STRUCTURES

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ABSTRACT

Laptop orchestras and ensembles, like smaller acoustic ensembles, have flexibility in organizational and hierarchical structures, often varying from piece to piece. These pieces usually have many organizational structures at the same time. Understanding these organizational relationships within pieces (how their control information and musical information flows) will help composers and laptop orchestras describe and classify past and future works. Understanding these organizational relationships within pieces (how their control information and musical information flows) will help composers and laptop orchestras describe and classify past and future works.

Two main organizational concerns in laptop orchestras are performance and control structures.

Performance structures mainly deal with (but are not limited to) 1. the immediate interface of the performer (i.e., use of joystick or golf trainer, etc), 2. the type of musical semiotics the performer will interpret (i.e., musical notation on 5-line staves to typed words on the laptop monitor to gestures delivered from a conductor, etc) 3. the relationship of performers' roles to one another.

Control structures mainly deal with 1. how information, usually on a non-musical level, is disseminated (i.e., local area networks, MIDI Control data, Open Sound Control, Bluetooth connection, etc), 2. timing and event methods (such as time-sync), 3. global parameter changes, 4. underlying programming language (ChucK, SuperCollider, Max/MSP/Jitter, etc).

While composers and ensembles have attempted to classify and catalogue previous works, many common naming systems fail in several ways: using cultural/regional/vernacular vocabulary (using forms of government or socioeconomic terms like 'democratic' or 'socialist'), not recognizing the control structure, and/or not recognizing the performer organizational structure. This poster examines varying performance and control structures from pieces for Laptop Orchestras/Ensembles and proposes a nomenclature relating and limited to their performance and control structure.

GLITCH LICH: EVOLUTION OF AN INTERCONTINENTAL NETWORK BAND

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ABSTRACT

In this paper the authors, as members of the laptop network band Glitch Lich, discuss their evolution over nearly five years of performance. We detail our transition from a group exploring game theory to performers of network music and programmers of networking software. A brief overview of the technology developed and used by the band is provided. In conclusion, we present a collection of new directions for the ensemble and network music as a whole.

1. INTRODUCTION

Glitch Lich is a laptop band comprised of members Cole Ingraham, Chad McKinney, Curtis McKinney, and Ben O'Brien. This quartet is unique in that its member reside in three different time zones, yet still perform together despite separation by thousands of kilometers. To cope with over seven and a half thousand kilometers of separation the quartet has had to devise innovative methods to continue collaboration.

The group met at Mills College where their studies focused on the practices of improvisation with electronics, just-intonation, and game theory. Early works utilized Open Sound Control (OSC) based networking, however public performances of these compositions were plagued with packet loss, dropouts, or disconnections. Glitch Lich resolved these network problems with the creation of OSCthulhu, a flexible system of abstracted *SyncObjects* and *SyncArgs*. Inspired by network mechanics found in multiplayer videogames, members of the band formulated the open-source client-server architecture to allow for better synchronization of audio and visuals for global performance. OSCthulhu is now at the core of every Glitch Lich performance, allowing the ensemble to perform on slow and even intermittent connections.

Network music compositions first emerged in the works by the League of Automatic Music Composers. Each new composition was a product of the soft/hard-ware instrument configurations designed by The League members. Communication between members was achieved by directly soldering connections between computers, which subsequently resulted in a fragile network prone to errors. Years later, the computer band the Hub was created, including former "League" members, and utilized a server based approach to networking. The system allowed members to share a common memory for the ensemble as well as communicate via a client-server architecture. Hub member Scot Gresham-Lancaster writes,

> "... [T]his music is idiomatic and requires a special understanding of the software and hardware being used. The inherent ironies in this approach are clear: these pieces of music can never be repeated exactly, and it would be very difficult to reconstitute the exact state and setup that made up a given performance." [6]

With the emergence of MIDI, the Hub adapted a MIDI-based system which simplified the network upkeep but absolved a shared memory environment which, in turn, altered their musical approach. John Bischoff, a member of both The League and the Hub, recalls,

> "...the relationship between issues of music time vs. hack time and robustness were not very different in the last analysis. I see both groups as having a slightly different angle on the concept of network music but at the same time being equally successful musically and technically."[3]

The work The League and the Hub created demonstrates how their specific artistic demands were both satisfied and altered as a result of the evolution of computer technologies.

Over the past decade there has been a significant presence of network laptop orchestras around international universities. With the advent of the OSC protocol, countless university laptop ensembles began surfacing and composing

works which utilize User Datagram Protocol (UDP) messaging [13] [11]. Audio programming languages such as ChucK and SuperCollider have implemented OSC, allowing for bands such as PowerBooks Unplugged to share code in real time [9]. There are many benefits to this form of communication, mainly that group members may be remote and it is not necessary to have their individual public and private IP endpoints. Additionally, the strain on the server is minimal as it is only a point of transmission between users.

The Princeton Laptop Orchestra (PLOrk) is an example of a laptop ensemble which has written works centered around OSC communication. For example, in the composition *CliX*,

> "a machine conductor synchronizes and quantizes the sounds triggered by each players keyboard by emitting periodic pulses via OSC, leveraging the computer to augment the degree of control offered by the keyboard."[5]

Though OSC is straightforward and robust, it does have several shortfalls. The use of UDP requires that a system rely on extensive synchronization between peers which may suffer breakdowns due to packet loss.[1] With this knowledge, network music ensembles must coordinate appropriately to prepare for the potential problems of lost data.

This article explores the aesthetic and technical approaches of the laptop network band Glitch Lich. A brief series of statements from the members is followed by a historical documentation of their performance practice. Afterwards, the penultimate section addresses technical details, before a conclusion including comments on potential future work.

Figure 1. *Glitch Lich logo*

2. AESTHETICS

Networking is not a style or genre, but rather a technique. As such, there can be many ways to write music for such an ensemble. The following are a series of statements by the members regarding their approach to writing music for a network band. By including statements from each member, the differences and similarities within the group will be highlighted, providing a holistic representation of the group.

[1] Packet loss occurs when one or more packets of data are sent from one network endpoint and fail to reach their intended destination.

2.1. Chad McKinney

Glitch Lich is a band with a philosophy and any philosophy deserves a manifesto[12]. Glitch Lich demands: 1. Steal. Steal from the performers, from the audience, from the internet. What is out there is for the taking. 2. Share. Make what is yours available to the performers, the audience, and the internet. Don't hide behind your computer. Also, if you have to chat, show the messages. 3. Don't be used, use. Performers are composers, there are no second class citizens. Every member must write music and code and do so often. Make yourself better and push each other. 4. Network music is not about tools, but relationships. Maintain control over all the elements of a performance, but keep the focus on the band.

2.2. Ben O'Brien

Performing with Glitch Lich is unlike most ensembles. Glitch Lich composers still have rigorous demands for the other members, and there is a certain need for work-shopping. But these necessities are allocated to atypical-to-traditional-music-performance directions. A commonality is an understanding of all the facets of the performer's instrument; in this case: the computer. In short, knowing the whereabouts of files, ability to execute files in real-time, network accessibility, etc., can be compared to knowledge of fingerings, dynamic control, extended techniques on the guitar. This of course is basic knowledge, and the best way to better understand one instrument is to push it into arenas unfamiliar to one's own knowledge. I am reminded by Paul Lansky's quote:

> "If you want to work at a professional level, I think it is best to think of yourself as somewhat analogous to a professional driver. You ultimately want to design your car, and when it breaks you want to be able to pull over to the side of the road, lift the hood and fix it yourself."[4]

Members of Glitch Lich have inspired me to better understand my instrument. Composing works for them have revealed worlds of problems that I would not otherwise uncover, and as a result I have discovered personal compositional interests relating to composition, improvisation, and computer translation.

Speaking to the aesthetics of Glich Lich, I first look to our method of networking. As Glitch Lich employs a network system for communication which resembles that of online multi-player games, it is logical that the music reflects this type of communication. While there are some sonic qualities similar to popular 8-bit video games from the 1980, Glitch Lich's approach draws from the vein of Classical music: present a musical idea, elaborate on it, propose the question - to the listener - of whether the musical state is sonically similar to the original, and then decide to return

to the initial idea, or repeat the process with a new musical germ. In works such as *Neuromedusae* and *Yig*, there is a score that dictates the cycling through SynthDefinitions, allowing performers and listeners alike to draw similarities to the materials. The result is a sense of forward-trajectory while relying on a relative process for music-making. Personally when composing for Glitch Lich, my focus is shifted to designing structures that concentrate on interactivity, malleability, and noise - which is not to say that my personal work does not engage in this manner. But rather, my concern lies that given my knowledge of the performers, how will they push my structures into unknown realms, and how will their collective mindsets effect the composition. With every performance there is definitely a sense of excitement which I believe is incredible given all the performers are scattered across the globe.

2.3. Curtis McKinney

Network music is something of a personal matter for me. It found me, but in a lot ways it's perhaps the kind of music I feel most comfortable with. Growing up with a twin brother(Chad McKinney), collaboration has been my natural mode for making music my entire life. Thus, when Chris Brown and John Bischoff introduced us to the concept at Mills College, it simply made sense. Why *not* play electronic music with the same fundamental collaborative energy that we have been using our entire lives? However, for me the promise of network music is more than that. Not only may you play with the same level of interaction as an ensemble of acoustic instruments, network music allows you to reach down to an even deeper level of interaction and dynamism.

To me that is the heart of the matter, and that is exactly what Glitch Lich as a band stands for. While being able to perform with my bandmates despite our different locales has been extremely useful, it is not really the point of the music. In fact it would actually be more advantageous if we were to be in a single locations. For me, the central theme is to construct an assimilated whole that is greater than the sum of its parts, producing a music that is the combined efforts of its participants. During this interplay, there is a constant shifting of roles, interaction, dependency, and identity, it brings an exciting liveness to performance that satisfy all my musical desires as a performer. This oscillation between group-identity and self-identity is part of the narrative drama of performing with Glitch Lich. In a rather fluid manner your performative gestures may slip from solo, to accompaniment, to joint manipulation of a single sound, to losing the ability to exactly decipher just how your action is manipulating the group's electronic morass.

I've attempted to give a label to this style of music making that I'm trying to achieve with Glitch Lich. Given that these electronic compositions are essentially serving as artificial instruments played by multiple individuals, I have come to call them Network Based Multi-user Instruments, or NMI's. The aesthetic construction of these NMI's has been the central focus of my research during my PhD studies. For an NMI to be successful in the setting of Glitch Lich I feel that there are certain criteria I want it to achieve. The instrument must allow for close-knit real-time interactivity of performers, it must have the ability to be composed for, and it must have some sort aestheticized visual presentation that helps to clarify the music and the network interactions to the audience as it is performed. The visual presentation of these instruments has become a more and more important facet as the band has evolved. What I've discovered is that while people have a strong willingness to understand and appreciate the underlying structures of network music, sometimes it is rather opaque. However it doesn't have to be this way, and the more I've worked to let the audience in past the liquid-crystal wall, the more they seem to appreciate exactly what's going on, and thus appreciate more the music itself.

2.4. Cole Ingraham

The ability to collaborate with musicians in real time over any distance in any situation where there is internet has opened up an amazing amount of possibilities for me both as an artist and performer. Being a part of any long standing ensemble always brings with it a high level of musicianship which every performer appreciates. The simple fact that the members of Glitch Lich were moving to different parts of the world would mean the end to most groups. However, due to the nature of network music this is a non-issue.

In fact, our geographical dispersion has been beneficial for us. It is easy, and rather common, for Glitch Lich to perform in the UK one night, and the US the next. We have even occasionally performed in multiple locations simultaneously. Being able to tour in multiple states and countries without needing four plane tickets is something that most quartets could only dream about.

This mode of working also inherently fosters collaboration: not only in performance but in the creation of the music. It is commonplace for one member to initiate a piece and the others constantly contribute to its development. The entire group then feels a sense of ownership in every work and that makes every performance that much more personal.

3. PERFORMANCE PRACTICE

Performing as a laptop ensemble requires many decisions to be made about the interactions between the performance and their presentation to the audience. When Glitch Lich (then known as the League of Art Game Composers, or LAG) began performing together in December 2007 the ensemble was looking for ways to make their laptop performances

more relevant to the music and the audience. Previous work from the members went little beyond tweaking GUI knobs as a fundamental performance element. Audiences were confronted by the back of laptop screens and the opaque information provided by occasional typing as cues for the performer's involvement. The history of the group is as a series of solutions where each new system is some attempt to solve the problem in a new and novel way.

3.1. Game Systems

The group's first attempt to solve these performance issues was to use games and game like systems as fundamental structures. This approach was inspired by several composers and artists including John Cage, Marcel Duchamp, Yoko Ono, and John Zorn who incorporated game structures into their work [7]. By using boards games, card games and video games, the member's actions during a performance became not only relevant but more transparent to the audience. *Red King Snoring vs The Octopus Knight*, a work featuring an electronic chess board connected to a laptop running SuperCollider, sonified the movement and capture of pieces allowing the natural structure of the match to govern the flow of the music. By using the game as the input into the system, performer actions were made more transparent, however the were still many layers of abstraction in the system. The mapping of any event is arbitrary when it could be mapped in any number of ways, so while the performances became more theatric, the level of direct control over the music decreased.

Several works by members explored the use of games and the varying ways they could be incorporated into a performance. Often the game itself was a controller, such as the work *Castlevanian Noise Vampire* by Chad McKinney, where the performer plays a gameboy and the output is manipulated in realtime. However other works, such as *Pong* by Cole Ingraham, flipped the problem on it's head by using pitch and onset detection of instrumentalists to control a video game. From 2007 to 2009 the group used several games such as Chess, Samurai Showdown, Koi Koi, Pong, Castlevania, and invented games to control laptop performances. However after almost two years of experimentation the group wanted a new direction.

3.2. Local Networks

While studying with John Bischoff and Chris Brown at Mills College the members were encouraged to make network music. The ensemble's previous work only indirectly addressed performer interactions and often times performances only used a single laptop. The group decided to change direction and attempt something more similar to the League of Automatic Music Composers or the Hub. New works were written and new systems were made where members used

Figure 2. *Performance at the 2008 Signal Flow festival in Oakland, CA*

laptops connected to a local router via ethernet to facilitate network performances. Concerts featured the ensemble within a sprawl of cables and interfaces on two large, and often plastic, tables. By now the group had solidified itself as a laptop quartet with members Cole Ingraham, Chad McKinney, Curtis McKinney, and Benjamin O'Brien. Coding skills became increasingly important as each new system pushed the complexity of the group's codebase.

The concert at the University of the Pacific in November, 2010 is a typical example. The group performed several works featuring custom systems that enabled rhythm splicing, code sharing and manipulation, and game elements. The theatrical interfaces such as the Chessboard and Koi Koi cards were missing. The ensemble became more computer centric and because of this took on the problems of that presentation. However now that the ensemble focused on network performance, each member's actions were important to the work at the most fundamental level. Portraying these connections to the audience was still a challenge and often visualizing programs were designed to break open the systems for the audience's benefit. The network connectivity also introduced the ability for the members to use chat during the performance, allowing fast and silent communication that was only possible in a computer ensemble.

The group was performing regularly, however organizing rehearsal could be difficult. By using OSC for networking they were able to rehearse in separate locations, however their systems were not designed to withstand packet loss which could create asymmetrical program states quickly. Furthermore, the group's reliance on OSCgroups, a system for routing OSC messages between users, introduced significant problems due to firewalls and routers [2]. A mem-

ber's router model or current location (often colleges) could completely block osc traffic, preventing rehearsal or performance.

The group also experienced the growing pains of maintaining an increasingly large and changing codebase. Their reliance on SuperCollider required each member to keep copies of other member's classes on their system, however this introduced many problems when members were on different versions of SuperCollider. The practice at the time of using Google Wave or e-mail to disseminate and track code updates created problematic scenarios. Rehearsal were marred by bug hunts and often no piece was even completely played through.

3.3. Distributed Networks and Current Practice

February 7th, 2010 marked the first multiple site performance by the ensemble. The concept was ambitious: Cole Ingraham was present at Montana State University while Chad McKinney and Benjamin O'Brien performed from Mills College in Oakland, CA and Curtis McKinney in Oklahoma City. The concert featured new pieces with advanced user interfaces written in Java to communicate with SuperCollider. These new systems featured locally rendered audio on all machines allowing for performers to be in different locations without streaming audio. It was called "Digital Sunrise of the New Era". Despite the grandios title, the performance with rife with technical problems.

The ensemble was able to find time to rehearse before the members separated, however this was always using the same router. At the performance the firewalls between Mills College and Montana State University proved to be too difficult for OSCgroups. Throughout the course of the concert there was realization that the members in California could communicate with Curtis in Oklahoma, and Cole in Montana could get some of the communication from Oklahoma, however California and Montana were completely separated. This created bizarre system states and furthermore the performers had no way of communicating to each other inside their systems.

After the show the group decided some measures needed to be taken to solve many of the problems with the ensemble. Version control through Subversion became mandatory for any code that would be shared among members. This quickly cleaned up the code base and made updates seamless, especially for projects with multiple authors. To solve the problems with OSCgroups, a new OSC client and server architecture was proposed. Something that could deal with any firewall or router and would also feature synchronization to overcome packet loss. This led to the development of OSCthulhu which will be discussed in further detail in the next section.

Glitch Lich has performed many times since the Digital Sunrise event, and has experiences several other issues in subsequent performances. Before a recent performance in Boulder, Colorado, band members were still attempting to compile key software components after an update. By the time of the concert, only two members were able to perform. It has since become a rule that authors of software must provide precompiled binaries for both 32bit and 64bit architectures and for all versions of Operating Systems that are used by the various members of band. Furthermore, every system must have a fail-safe mode that allows it to seamlessly transition from networked to local modes and back, for when network connectivity is completely lost or becomes too unstable. This rule follows the group's performance at the 2010 SuperCollider Symposium in Berlin. During their performance of the piece *LAGMonster* the server crashed. Without a local mode, the piece was halted after only thirty seconds.

These measures have proven to be quite effective and Glitch Lich has gone on to perform regularly as a transcontinental ensemble with members in three different time zones. In fact it has been over two years since all four members have been in the same location. However because of the separated locations of the ensemble, performances now must be concerned with how to portray members in separate locations to the audience as well as guide performances without the use of visual cues. Rehearsing can be difficult as well with a seven hour difference between the furthest members of the ensemble. However, Glitch Lich continues to research new possibilities for network music and maintains a steady performance schedule.

Figure 3. *Performance at the 2012 Network Music Festival in Birmingham, UK.*

4. TECHNOLOGICAL FRAMEWORK

Throughout its history as a band Glitch Lich has gone through several iterations of technological frameworks to facilitate

network performances. As the sophistication of the group has increased, and as the aesthetics of the ensemble have changed, several new technologies have been developed and utilized to match the requirements of the band at that time.

4.1. OscGroups

For the first iteration of Glitch Lich's networking technologies the NAT-traversing OSC sharing application OscGroups, by Ross Bencina, was chosen to be the central lynch-pin for the band's work. Using OSCgroups the band started to create compositions focused on their four laptops interacting in some fashion. These piece such as *Quartet for the End of Space*, a group controlled meta-instrument, were of increasing technical complexity and networking interplay. Due to OscGroup's unique NAT-traversing capability, this also marked the band's first experiments with performing in separate locations. To accomplish this the group revived the technique introduced to them at the RML gig with Chris Brown.

Each of the member's computers would locally render all of the sounds and visuals generated by each of the members control information output. This allowed for the members to perform in disparate locations without needing high-bandwidth internet connections. It also made it possible to have deeply interactive musical systems that influenced each other's musical output. While OscGroups did allow for NAT-traversing of fire-walls and routers, it did not always play well with academic networks. Furthermore, even with established connections, delivery of packets was not always guaranteed. This led to chaotic scenarios in which sounds or objects would exist on some of the member's computers, but not other's.

4.2. OSCthulhu 1.0

As the members left Oakland to pursue PhD research at separate institutions these issues of networking over large distances became of paramount importance. It was decided that a solution should be devised to meet the group's specific needs. It was for this reason that Curtis McKinney set out in April 2010 to create a custom made networking utility for the band, which would eventually come to be known as *OSCthulhu* (a play on OSC and H.P. Lovecraft's mythological demigod Cthulhu). This tool was heavily influenced by OscGroups, with its central task being the reliable delivery of OSC packets over the open internet.

A major structural decision was made to both increase the reliability of firewall/router penetration and the successful delivery of OSC packets: OSCthulhu would forgo OscGroups' NAT traversing mesh-network structure for a more traditional client-server model. Furthermore, OSCthulhu borrowed networking techniques from first-person shooters to increase the reliability of network traffic. By defining the entirety of the sound world as a *Sound-state*, the server could send synchronization messages at a regular interval to help combat lost packets, while maintaining use of musical gesture-friendly UDP. Version 1.0 was constructed as a java-based library, as at this point Java was the main programming language being used for compositional logic and visualization. This system proved to be much more reliable overall, and many successful concerts were given using it [8]. However, there were several issues. It severely restricted the implementation style for compositions, due to it being tied to a specific programming language. Furthermore the server itself became a point of failure, due to the possibility for secure-shell ssh time outs to cause the server end its process loop [1].

4.3. OSCthulhu 2.0

Version 2.0 of OSCthulhu was created to help solve the issues of version 1.0, as well as to add new capabilities. OSCthulhu 2.0 was programmed in C++ instead of Java to give it as little overhead as possible, and to make it more compatible overall [10]. Instead of being developed as a packaged library to be integrated directly into a composition's logic code, version 2.0 is designed to be a separate application that may be interacted with through an OSC based remote API. This provided a much higher degree of flexibility for implementation, as OSCthulhu 2.0 didn't restrict users to use Java.

The server architecture was also modified to be run as a daemon process on the open internet, so that OSCthulhu could be used at any point in time, without the need to rely upon an ssh session, which has the possibility of timing out, to run it. Extra features were added, including built-in chat functionality, an automatic reconnection scheme in case of disconnections, and the ability to broadcast OSCthulhu messages to multiple applications. The reliability of the system has allowed the group to create systems that require a high degree of interconnectivity and interactivity, with the simultaneous presentation of networked sounds and visuals, all the while performing from an extremely varied set of venues with differing technical setups. Due to the low bandwidth of the system, approximately 24 kilobytes/second on average, 3G phone networks may even be used in a pinch in lieu of a cabled internet connection.

5. CONCLUSIONS AND FUTURE WORK

Despite technical difficulties related to physical and temporal displacement, Glitch Lich continues to perform as a band. Much music and code has been written by the members and they continue to refine their technical skills. Other laptop bands looking to perform over long distances could potentially benefit from many of the solutions and procedures the band has adopted . Of key importance is a system to address both latency and information loss in the network.

Other important ideas include version control for code, precompiled binaries of software for all versions of operating systems the band members run, orchestrated simultaneous updates of key software, fail safe modes for complete loss of network connectivity, and beta testing performance software. However, technical issues cannot be the sole focus for a band. It is important to consider what makes network music unique and how to write for a disparate group.

All four members of the ensemble are doctoral students actively engaged in academic research. Much of this research focuses on issues in network music and often becomes a part of the Glitch Lich canon. Benjamin O'Brien is currently exploring interconnections between performers within complex hierarchies. His work bridges the gap between hyper-structuralism and free-improvisation. Chad McKinney has recently completed a new open source network music environment, Yig, that allows for the creation and manipulation of feedback matrices. He is currently developing new tools and techniques for network music environments including the usage of 3d worlds in performance. As the main contributor to OSCthulhu, Curtis McKinney is establishing the next generation of client and server architectures for musicians. He is also actively developing systems for cooperative sequencing and visualization. Cole Ingraham is currently investigating generative procedures using chaos in musical and visual contexts.

6. REFERENCES

[1] D. Barrett, R. Silverman, and R. Byrnes, *SSH, the secure shell: the definitive guide*, ser. Definitive Guide Series. O'Reilly, 2005.

[2] R. Bencina, 2010, available from: http://www.audiomulch.com/~rossb/code/oscgroups/ [Accessed 2 May 2010].

[3] J. Bischoff, "Unpublished e-mail to scot gresham-lancaster," 1998.

[4] D. Cope, *New directions in music*. Waveland Press, 2001.

[5] R. Fiebrink, G. Wang, and P. Cook, "Dont forget the laptop: Using native input capabilities for expressive musical control," in *Proceedings of the 2007 Conference on New interfaces For Musical Expression*, 2007, p. 3.

[6] S. Gresham-Lancaster, "The aesthetics and history of the hub: The effects of changing technology on network computer music," *Leonardo Music Journal*, 1998.

[7] C. McKinney, "Metagaming: Experiments With Art And Games," Master's thesis, Mills College, 2009.

[8] S. Reges, *Building Java Programs: A Back to Basics Approach*, 2nd ed. Addison Wesley, 2010.

[9] J. Rohrhuber, A. de Campo, R. Wieser, J.-K. van Kampen, E. Ho, and H. Hölzl, "Purloined Letters and Distributed Persons," in *Music in the Global Village Conference 2007*, 2007.

[10] B. Stroustrup, *The C++ programming language:*. Addison-Wesley, 2000.

[11] D. Trueman, P. Cook, S. Smallwood, and G. Wang, "Plork: The princeton laptop orchestra, year 1," in *ICMC '06: Proceedings of the 2006 International Computer Music Conference*, 2006.

[12] A. Ward, J. Rohrhuber, F. Olofsson, A. McLean, D. Griffiths, N. Collins, and A. Alexander, "Live Algorithm Programming and a Temporary Organisation for its Promotion," in *read_me — Software Art and Cultures*, O. Goriunova and A. Shulgin, Eds., 2004.

[13] M. Wright, 2002, open sound control 1.0 specification. Available from: http://opensoundcontrol.org/spec-1_0 [Accessed 2 May 2010].

HOLOFRACTAL TRANSDUCER OF MUSIC & IMAGE SYSTEM: A POST-MODERN MUSICAL INSTRUMENT FOR LAPTOP ENSEMBLE AND ORCHESTRA

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ABSTRACT

The Holofractal Transducer of Music & Image (HTMI) system is a Max/MSP/Jitter 5 patch developed for interactive music, dance and performance art experiments in order to emphasize new paradigmatic concepts – such as holonomy and fractality – by means of transducing webcam captured movements or any accelerometer device (smartphone, wiimote, tablet, etc.) into live synthesized and granulated sounds and live processed and transformed images. Beyond its richness as a solo performance instrument, the HTMI offers countless possibilities for ensemble and orchestral use, as a music digital complex instrument with network interaction capabilities, especially under experimental approaches. The version 1.05 of the system is available for downloading, under a CC license (BY-NC-SA), at: <http://bit.ly/HTMI105patch>.

1. INTRODUCTION

The holofractal aesthetics is an artistic approach that entangles the most important notions of contemporary physics – especially the ones derived from the holonomic theory, the chaos theory and the fractal geometry, such as unpredictability, acausality, relativity, non-linearity, paradoxicality, uncompleteness, multidimensionality – taken as a new paradigmatic ground [4]. Post-modernity is the usually known label for this new multiperspectivistic worldview in arts, supported on concepts like interdependence and interactivity, but the holofractal poetics is more conscious of the natural origins of those complex interconnected notions and look for a deeper comprehension.

Therefore, the Holofractal Transducer of Music & Image system (**Figure 1**) was developed as a virtual instrument to make it easier and faster to generate sounds and images accordingly to the holofractal aesthetics. It is a Max/MSP/Jitter patch that integrates several modules, like FM synthesizers and granulators individually spatialized up to eight channels, webcam capture transducers, file players, an ADC-to-midi converter, a Greek modes midi player, a midi patch bay and a remote controllers (for accelerometer devices) patch bay, besides some video FX and blenders that will not be treated here. Some of these modules were adapted from successful Max patches, libraries and external objects credited ahead.

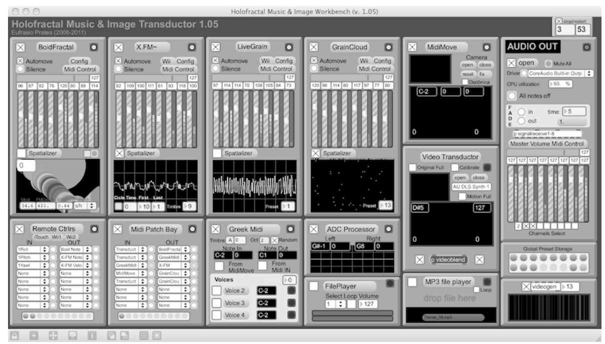

Figure 1. HTMI system's main screen.

As long this is a limited space for a complete description of such complex system, this article will present its main functionalities, followed by an analysis of its ensemble potentialities including a short exemplary case.

2. SYNTHESIZERS AND GRANULATORS

2.1. BoidFractal FM Synthesizer

This FM synthesizer is based on John Bischoff's patch FM Surfer, bundled with Max/MSP 4, and on "Boids for Max" from Simon Fraser's implementation of Craig Reynolds' Boids algorithm. It converts the data flow from the flock simulator visual objects mapping into FM waves inputs, allowing an automated unpredictable playing, by means of controlling boids parameters (quantity, gravity, friction, separation). Some transformations were applied to the patch in order to enhance mathematic iterative and fractal operations in the generation of microtones, which naturally result from Chowning's FM non-linear technique [5].

Besides controlling many synthesis parameter, BoidFractal synth is able to receive the numeric flow from the webcam transducers, remote controllers, midi devices, including network midi data, and it has two automated independent spatializers, one of them based on Christopher

Keyes' "Stereo-to-8 Channel Panner", as it happens to all HTMI sound producing modules, described ahead.

2.2. X-FM~ Synthesizer

The second FM synthesizer in HTMI is an adaptation of the X-FM~ patch, bundled with Max/MSP 5. The main changes include an automated random player and the individual remote controlling of five oscillators parameters (time, depth, frequency, range), which allows the data input from one of the webcam transducers, remote controllers, internal and external midi devices, including network, and two different eight channel spatializers as well.

It complements the BoidFractal synth because it is able to play recognizable frequencies (tones), if desirable.

2.3. LiveGrain~

This module is a real-time granulator based on the GMU external MSP object **liveGranul~**, by Charles Bascou and Laurent Pottier [1], capable of decomposing, treating and transforming live sound into a granular synthesis flow.

The live processing includes triggering, delaying, detuning, panning, filtering and amplifying the sounds from several sources, like one of the FM synthesizers or the ADC.

2.4. GrainCloud~

This second real-time granulator subpatch intends to produce clouds of grains in a diverse approach, i.e., reading a wave file. It is based on Christopher Keyes' "Real-time Granular Cloud Maker" patch, which is able to generate synchronous or asynchronous grain clouds under different window shapes.

The main adaptation of this subpatch is the opening for external data input, allowing midi, remote or webcam live playing.

3. WEBCAM TRANSDUCERS

3.1. MidiMove

The MidiMove is a module destined to capture movements in front of a web camera by means of comparing frame differences, task developed by the Jitter objects **jit.change** and **jit.op**, and to convert them into midi information, like notes, velocities and control changes, under flexible configuration. It may be noticed that this kind of interface may respond to a high level of performance reproducibility, as pointed by Ferguson and Wanderley about the development of new digital instruments [2]. However, the holofractal perspective tries to emphasize the opposite, i.e., reducing the possibility of reproducing the exact same sound as response to the same gesture, increasing its unpredictability. Of course similar results will be obtained by the repetition of a gesture under the same system configuration and light condition, in particular when configured to play exclusively the diatonic scale and a high cue time interval.

Beyond generating midi output, the images grabbed by this subpatch are processed and filtered to compose a projection, which is useful to enhance the perception of the transduction between motion and sound and to enrich its visual potentialities in concert, performance or installation.

To deal with environmental light changes, the MidiMove offers an automatic and periodic threshold calibration algorithm.

3.2. Video Transducer

A second subpatch for video motion processor was added to the HTMI system, aiming to control another camera simultaneously, based on Jamoma's motion tracking objects, part of the modular library developed by Tim Place, Trond Lossius et al.[1] Similarly to the MidiMove, it converts captured movements into midi data, but includes the possibility of grabbing images from other sources, like video files or desktop screen. Another difference is the extremely precise threshold calibration, sometimes suitable for stable light ambiences.

4. CONTROLLERS

The controllers patch bay modules are a core functionality of HTMI because they allow the simultaneous connection of internal and external data flow producers, as the webcam modules, wired and wireless devices, and the network incoming midi data, to the sound producing modules, like synthesizers and granulators.

4.1. Midi PatchBay

This subpatch allows the connection of internal data flow output modules, like the cam transducers or the Greek scales midi player[2], to the input synthesizing ones, as the BoidFractal or X-FM~. All combinations and replications are allowed up to eight simultaneous data flows.

4.2. Remote Controllers

The situation of live performance was the main reason to the development of these modules. They allow the simultaneous connection of wireless devices (wiimotes, smartphones, tablets), via OSC[3], to any synthesizer and even to the Greek scales player, controlling notes, velocities and cc messages by the X, Y and Z three-dimensional axes, and accelerometer data as well.

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[1] See detailed information at www.jamoma.org.

[2] This module is based on V.J. Manzo's Modal Object Library.

[3] OSC or Open Sound Control is a modern networking technology, more accurate and flexible than MIDI protocol.

5. SPATIALIZERS

There are two different kind of spatializers embedded on the HTMI audio-out subpatches: AudioMix8, a simplest less CPU consuming algorithm, and the Stereo-to-8 Channel Panner which is an eight channel mixer, and a more complex one.

5.1. AudioMix 8

Every DAC output module of HTMI system is provided with an eight channels subpatch, capable of individually controlling the signal amplification of each channel in dB. An automatic volume change is provided to produce different step increasing or decreasing for each channel, allowing the creation of virtual source unpredictable movement in space, at very low rates of CPU consumption.

5.2. Stereo-to-8 Channel Panner

This subpatch is a slightly transformed version of Christopher Keyes' original patch, designed to pan a stereo sound source up to 8 speakers under several automation controls, like periodic moving back and forth, in ellipses or circles.

The main change in these modules is the adaptation for a flexible number of signal inputs, between 1 and 4, and the possibility of outputting the spatialized signals in less than 8 channels. There is one independent instance of this module for each synthesizer and granulator of the system, enriching the possibilities of different, but simultaneous, space behaviour from each signal source, evidently priced on high CPU consumption.

6. PLAYERS

The ability to play **wave**, **aiff** and **mp3** files is certainly useful in many situations, even in live improvisation, mainly because some sounds are still too complex to be generated in real-time. For that reason, the HTMI system received special players.

6.1. FilePlayer

This module is based on the MSP object **sfplay~**, which handles **aiff** and **wave** files in basic operations, like play, pause, resume and loop. It is programmed to memorize up to six files on a row and spatializes stereo files up to eight channels.

6.2. MP3Player

The mp3 file player module is based on Kovács Balázs' "Moiré Mp3 player", a patch full of playing effects and controllers like reversing, partial looping, time stretching and automated envelops, including a random generator based on the Litter Power library object **lp.poppy~**. It was included an AudioMix 8 subpatch to this module to allow manual or automated amplitudes spatialization.

7. POTENTIALS AND LIMITATIONS OF THE SYSTEM FOR LAPTOP ENSEMBLE AND ORCHESTRA USE

The HTMI system is more than a virtual instrument, better described as a complex group of virtual sound processors, operated by several non-traditional interfaces and devices, completely integrated as an ensemble to be played by only one individual. Nevertheless, it brings a huge potential for collective use in laptop ensembles and orchestras. To name a few, one may think of:

a) converging the webcam from each laptop to the conductor and patching them to the same synthesizer with the same selected parameters, in order to explore the subtle changes in sound that will result as a product of slight differences in distance, angle and lighting; or the exact opposite, using the same source of movement in very different sound modules and configurations;
b) supporting the conduction on sending OSC messages from a baton-like wireless device, like a smartphone or a wiimote, to one of the computers and patching the incoming data to another by the midi networking, and so on in chain, in order to create and explore time lagging results;
c) using the same sound file across all computers, synchronized started, and slowly allowing each musician to change its parameters and spatialization;
d) programming the boids to start under the same parameters and letting their unpredictable behavior raise the chaotic level.

Besides those, many interesting possibilities rely on the mixing of the digital instruments to acoustic ones, especially if they are connected to a special module of the system, the ADC-to-midi converter, a transducer of analog sounds into midi data. In the case of an acoustic solo instrument, it can be captured and converted by one of the computers e resent to the other ones. Playing gestures may also be captured by both motion trackers and be used for numerous finalities in HTMI system.

Despite the openness of this system, or better, exactly because of that, it is not suitable for some compositional approaches; in particular the stricter and more controlled ones, based on the expectation of reproducibility. On the contrary, it was programmed to respond largely on live improvisation and interactive environments, even involving the audience as an active player and co-author, with ever changing results.

Another limitation of the system is its high CPU consumption in the present version. It runs on Core2Duo 2 GHz with all functionalities turned on, albeit only up to 4 voices in X-FM~. The performance and sound quality is

significantly improved on quad-core processors. At last, the webcam grabbers do not work in Windows OS, a problem that is being addressed for the version 1.1.

7.1. Holofractal impromptu #19 for Laptop Ensemble

The "Holofractal impromptu #19: on Augusto dos Anjos' Sonnet 'Psychology of a Defeated' for Laptop Ensemble"[4], conceived by this author, is an example of what Fujak calls "comprovisation" [3], i.e., a hybrid of composition and improvisation, better suited for the HTMI characteristics.

Divided into three contrasting parts, the piece begins with the conductor controlling three voices (sound modules) in each of the seven computers. In the second part, the regent conducts only two voices. Meanwhile, the third voice is manipulated at each ensemble musician's will. It worth noting that the second voice is a fractal automata playing the synthesizer, which means that the conductor is only able to control its entrances and exits. In the last part, the reversion is complete: only one voice is conducted, while the two other lines are decided by the ensemble's desire.

The HTMI webcam transducer module in each computer develops a crucial task. The camera must be directed to the conductor, whose gestures are symbolically deciphered by the musicians and indexically transduced by the system, in such an angle that captures the audience motion as well. The public may or may not be aware of its direct interference in the sound production, at the discretion of the regent, and some projected images from the seven laptops may increase such perception.

8. CONCLUSION

As shown, the Holofractal Transducer of Music & Image system is a new software instrument suitable for solo, ensemble and orchestral use, particularly in post-modern art creative processes, where notions like interactivity, unpredictability, complexity, fractality are welcome. It was built in Max/MSP/Jitter 5 language, integrating its own solutions to patches designed by important members of the developers' community, such as Bischoff, Bascou, Pottier, Place, Lossius, Keyes and many others. It has a wide range of flexible, dynamic and live sound generators and players, but they are quite limited for playing strict scores and reproducible pieces. The version 1.05 of this system is available for downloading, under a CC license (BY-NC-SA), at: <http://bit.ly/HTMI105patch>.

[4] The complete guidelines for this piece are available online at http://bit.ly/HI19score.

9. REFERENCES

[1] Bascou, C. and Pottier, L. "Gmu, a flexible granular synthesis environment in max/msp", in *Proceedings of the Sound and Music Computing Conference*, Salerno, Italy, Nov/2005.

[2] Ferguson, S. and Wanderley, M. M. "The McGill Digital Orchestra: An Interdisciplinary Project on Digital Musical Instruments", in *Journal of Interdisciplinary Music Studies*, 4(2):17-35, Fall 2010.

[3] Fujak, Julius. *Musical correla(c)tivity: notes on unconventional music aesthetics*. Nitra (Slovakia): University of Constantine the Philosopher, 2005.

[4] Prates, E. *Música holofractal em cena: experimentos de transdução semiótica de noções da física holonômica, da teoria do caos e dos fractais no campo da improvisação performática*. Unpublished thesis (PhD). Universidade de Brasília, 2011.

[5] Schottstaedt, B. "An introduction to FM". Available online at: <ccrma.stanford.edu/software/snd/snd/fm.html> [Accessed 01 March 2012].

LAPTOP ORCHESTRA OF ARIZONA STATE: THE STUDENT VENTURE

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ABSTRACT

Laptop Orchestra of Arizona State (LOrkAS) an experimental sonic art performance collective, which integrates technology and [sonic art, visual displays, and interactive expression]. We are graduate, undergraduate, and industry researchers from various academic backgrounds and disciplines. Director Diana Siwiak, a Stanford Laptop Orchestra (SLOrk) alumna and ASU Media, Arts, and Sciences doctoral student, founded the troupe in Fall 2010. We are currently the only solely student-managed ensemble in the nation. Our poster presentation will feature a virtual discussion detailing the trials and tribulations of starting our own LOrk.

Some of the important benefits of being solely student-managed include the freedom for innovation, learning and honing leadership skills, starting a non-profit performance group from scratch, and, most importantly, keeping the troupe alive and sustainable. We each personally invested in the group and claim a sense of direct ownership. We will further detail more benefits at the Symposium as each day brings new, rewarding surprises!

Some of the important detriments include lack of funding and support (which lead to us finding creative ways to get a similar effect, as if we were to have the money and resources) and the inability to reward members for their time commitments through such facets as course credit

Despite all odds, we have managed to create a hacker-space for LOrks such that almost anyone can now create a LOrk.

ON FORM AND TEXTURE IN LAPTOP ENSEMBLE MUSIC

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ABSTRACT

This article describes the design and intent of a composition for four networked laptops entitled *Jargo's Table*. Programmed in ChucK, every station runs an identical client script and an individualized server script that sends control messages directed towards a particular musical parameter. The design of *Jargo's Table* does not rely on a one-to-one relationship between localized sound source and station allowing for changing textures without a score or conductor. While embracing the collaborative potential of music for networked laptop ensembles and orchestras (LEO), the author/composer contextualizes the design choice by addressing how the exigencies of LEO practice may unwittingly limit the variety of musical forms and textures explored by the medium.

1. INTRODUCTION

Jargo's Table (JT) is a composed improvisation for four laptops on a local network in which each station controls a musical parameter of the whole group-composition rather than the sound of an individual instrument. These parameters are rather starkly distinguished: 1) timbre; 2) pitch content; 3) rhythm; and 4) texture, or localization.

Programmed in *ChucK* [1], every station runs an identical client script and an individualized server script that sends messages directed towards a particular musical parameter realized on every station. The goal of the piece is to create a chamber music-like experience for the four, interdependent composer-performers creating "paths" through tables of pitches, durations, synthesis functions, and pulse values in real time, collaborating on a musical form with a varied texture. Without a score or conductor, this strategy allows for a synchronized, agile texture available to a "pulse-based" network of devices [2]. The players choose the localization of the parameter controlled by their station; so, while in practice, JT has relied on the PLOrk model of "laptop-based instruments with localized sound sources," such localization is not required for this design. [3] The experience of performing JT is not one of coordinating actions/sounds within an ensemble in space; rather, it is one of attending to the results of individual choices on an entire texture, a texture in which each player plays a crucial role.

I designed JT for an appearance of the West University Laptop Arts Ensemble at a TEDx Phoenixville event in 2010 and intended it as a kind of demonstration piece displaying a particular compositional scenario afforded by the technology. (Figure 1) The scenario responded also to an earlier composition for electric guitar and nine laptops called *Melancholy Science* created while I was a Visiting Artist with PLOrk in April 2010. In the earlier work, the electric guitar triggered controlled messages to a server influencing the degree of control possessed by eight other player-stations: at one extreme the soloist would seize control of all stations, at another, free improvisation for the individual player-stations would reign.

Figure 1. WCU Laptop Arts Ensemble at TEDx Phoenixville.

While in concept *Melancholy Science* addresses uneven allocation of control, JT's strategy establishes an *equal* allocation of control in a synchronized but free musical texture, one that does not rely on overtly layered textures. I see both designs as compositionally satisfying, but I would like to contextualize the particular design of JT in terms of what I will call the general "exigencies" of composing, performing, and listening to laptop ensembles and orchestras (LEO), thus addressing compositional-aesthetic "problems" that I have with the LEO medium, despite my attraction to it.

What I am calling "exigencies" might be better understood as routine HCI concerns: What is the competency of the technology user? How much time will the user spend with the technology? What sort of feedback will the user get from it? What sort of performance experience will they have? Other exigencies are relevant, though perhaps more mundane: How many stations can we afford at this time? Who will we get to perform in the next concert? Will our (music school) students and other audiences enjoy our concerts?

This article also seeks to address and question how logistical factors like these determine musical forms and textures in LEO music, as much if not more so than the technology. Being more of a composer than engineer, I've spent time composing and performing music for voices and instruments, and certainly this experience has shaped my compositional and aesthetic expectations concerning musical form. The implication that these criteria may unfavourably measure LEO music reflects my fuddy-duddy taste and bias. Nevertheless, the reader may substitute his or her compositional concerns for mine and reflect on the impact of these so-called exigencies in the short term as well as their impact on the role LEOs are to play in anyone's compositional practice for the long term.

2. MY EXIGENCIES: THE LEO IN THE MUSIC SCHOOL SETTING

While the LEO is typically an extension of a research program in composition or music technology, it still remains an anomaly in my conventional music school setting. The experience of performing and composing for LEO is new for everybody; but for undergraduate music majors—my chief collaborators—the novelty of the experience is manifold. This is wonderful thing pedagogically, but musical results vary. There are participants confident with performance though less so with improvisation and/or experimental music. On the other hand, there are confident improvisers who are nevertheless new to music technology, especially the DIY kind that LEOs require, etc. I have noticed in my work with the WCU Laptop Arts Ensemble and with PLOrk that instincts about improvisation and performance significantly determine the musical effectiveness of any given moment, and successful moments are hard to sustain. In many respects, music schools are well suited for growth in LEO performance, but the LEO does not sit comfortably in a typical music school curriculum. It will be sometime, for example, before our ensemble "fulfils ensemble credit" for performance or composition majors. Other practical questions arise in terms of situating the LEO as a priority: Is it practical for the LEO to be an extension of the typical new music ensemble? Should it really be integral to a core music technology class, when basic recording, synthesis, DAW, and control issues need to be covered, etc.? I am happy to echo the pedagogical benefit of the LEO, [4] but there's a nagging voice in my head that says: if the LEO is not clearly grounded in a technology-oriented research agenda, the "musicality" of it is a greater burden of proof, especially in an atmosphere cultivating musical "mastery"—for better or worse—as defined by tradition.

After a performance of *JT*, my colleague, a very experienced composer of instrumental and vocal music, recommended that I transcribe the performance and "orchestrate it for real instruments." It seemed like a spurious reaction to me at first, since I had regarded the mobile-like, open form of the piece to be its key feature. It occurred to me later that his reaction was not denying this feature, but somehow emphasizing it. He was suggesting *another* model for performing music with networked computers—a new way of *committing* to a particular path through the shared data. Ensembles of musicians have always suggested an underlying hierarchy, an implicit principle coordinating sounds as reflected in a unique musical form. [5] Such principles can be difficult to decipher in an LEO works. Efforts to render stations as 'composed instruments' have done much to allow the listener in space to connect action with sound, but musical forms also signal a level of commitment not always underscored by LEO practice. The mid-20th century avant-garde challenged such symbols of commitment by deskilling the virtuoso. Paradoxically, the LEO version of both what I call this "commitment," and its challenge, is *hacking* or meaningfully constraining the technology for aesthetic purposes; the conceptual emphasis, therefore, is on the *design act* rather than *performance act*, in spite of the clear intent to make computer music something performable. This is a curiously open, aesthetic problem, which I cannot fully explicate, but in my music-school milieu these subtle signs of "commitment" are intently listened for and scrutinized in musical forms.

3. 'PERMEABILITY' IN LAYERED MUSICAL FORMS FOR LAPTOP ENSEMBLES

Smallwood et al in *Composing for Laptop Orchestra* outline a variety of aesthetic directions towards which new works for LEO tend to gravitate. Most of these suggest a kind of textural composition well suited to the localization of sound sources: musical forms that bubble up from the collective activity of individual instruments specifically located in performance space. Aleatoric textures in the spirit of Ligeti or Penderecki in which the doublings of individual parts are otherwise suppressed in favour of unique parts localized in space are well suited to LEO groups in which sounds come from the machine triggering them. Indeed, strict doublings of machines synchronized via network have the effect of masking the distinctions that localization seeks to produce. (Parallel octaves are still an issue!) *Composing for Laptop Orchestra* also refers to the PLOrk sound as potentially a "matter of taste" when accounting for misgivings about the sonic effect of

localized sound sources. The WCU ensemble has adopted this mode of sound projection as well, but I am of a mind that *musical forms* favouring layered (often improvised) textures contribute more to any listener's remorse than the instruments themselves. Of course, when two or more distinct sounds are occurring simultaneously we are inclined to imagine a kind of spatialized "layering" of sounds. Music theorists have long borrowed visual metaphors like "juxtaposition" and "stratification" to describe musical texture. Nevertheless, there can be a flattening of the very dimensionality such layering and localization is meant to suggest, difficult to account for when composing for LEOs. [6]

Gyorgy Ligeti's classic critique, *The Metamorphoses of Music Form*, seizes on a central quality he heard in serial music that is arguably relevant to our efforts creating music for LEOs. Ligeti offers loyal opposition to the new music of the day when he laments the degree of 'permeability' obscuring the individuality of heterogeneous elements. By 'permeability' Ligeti describes how musical structures "...of different textures can run concurrently, penetrate each other and even merge into one another completely." He goes on to note how music exhibiting this quality privileges layering techniques and resulting textures: "The interpenetration of different structures [give] rise to those specific forms that are concerned with the superposition of several layers...pressed together into a simultaneous activity...the final form is thus the product of interferences amongst originally heterogeneous shapes." [7] For Ligeti, electronic music of his day also exhibited this quality, but he may as well have been describing LEO music that I have recently heard, made, continue to make, and often question. While the layering of soundscapes and textures with LEOs may be a preferred and logical approach to making music with multiple computers, the largely improvised forms and layered textures typical of the genre (if we can call it that) can also be the unfortunate bi-product of "exigencies" of practice—some more interesting than others:

No time to compose. No time to practice. One of the great challenges of composed-instrument design is deciding when to stop tweaking and start practicing (or composing). These actions constitute two distinct, almost irreconcilable processes; the more one "practices" the more ideas arise for additional tweaking; and so, the hacking continues until the bitter end. Indeed, hacking *is* practice and the kind of practice that instrumentalists engage in, if required, can seem a failure of programming or mapping. In any case, multiply the resulting crunch time by the number of stations and interface-concepts in one's piece and the improvised layer composition becomes the best compositional design choice.

Diverse experience of participants. That technology can level out differences among users in terms of experience and competency is commonly regarded as a significant benefit of interactive technologies. As fascinating and promising as this aspect is to a variety of researchers, it is rarely a motivating force in my compositional practice unless circumstances demand it (and with LEO performance, they usually do). I recognize qualities of "natural talent" for this kind of music making, an instinct to tweak, test, yet transcend and mould a given interface in performance; but, it is a rare talent, and built-in damage control is often necessary to maintain convincing performances. The improvised layer composition is a cushioning musical form that allows for a more inclusive LEO experience for participants. Such forms create a welcoming, drum-circle camaraderie that marks a new and wonderful kind of social music making and is pedagogically vital, but it limits potential musical forms, a limit not necessarily demanded or even suggested by the technology.

Humility before the vastness of potential directions. It is extraordinarily difficult at this point in time to imagine the listening experience of a piece for LEO, the way one might "audiate" a piece during the pre-composition of a work for conventional forces. Certainly, it is a matter of taste to even want to do so. Nevertheless, this aspect is yet another similarity to serial or Cagean music. Composition takes on an experimental "what-would-happen-if" approach that makes one inclined to regard the work as a document of process—of designing, testing, improvising, and layering. The piece marks a "lab report" along the way; and so, the degree to which LEO music can function as an affiliating or identifying force in the listening experience is much stronger for LEO participants than for other listeners. In general, the listener's experience of LEO music is under-explored territory, but Kassiabian's *affiliating* vs. *identifying* functions used to describe film music provide for me a working model to account for the listener of LEO music. [8] The visual tracking of gesture using alternative controllers is a tested mode of engaging the listener and shaping the experience visually; this would demonstrate an *affiliating* tendency, allowing the listener to recognize the intent and method to process and transform. The use of found samples, pre-existing music/traditions, etc. would contribute to an *identifying* function that draws on the listener's experience. Concerto forms, like *Melancholy Science*, for example, draw on tradition to help listeners *identify* with LEO musical forms. In any case, when mapping controllers to distinct voices for the sake of establishing this *affiliating* function, superimposed layers of heterogeneous (or more typically, homogeneous) timbres remains a favoured texture.

Automation Anxiety. The performability of computer music is of paramount importance in most LEO creations; otherwise why have so many people and so many machines? I have felt wary of too much automation, too many algorithmically determined musical gestures that

obscure human intervention/performance of the projected sound (again, in order to build affiliations with the listener). To overdetermine form seems a return to electro-acoustic music and hardly justifies the staging of players and machines. Nevertheless, this strikes me as a somewhat arbitrary constraint on the technology, and it limits the possibility of sudden contrast, or at least requires the presence of a score/conductor. Automation anxiety may indeed be the flipside of an aesthetic to hack existing technologies as celebrated by LEO music and experimental instrument design in general, and it is certainly assuaged by the quaint presence of a conductor in LEO performance. In any event, automation anxiety decreases to the degree that the process of intervention is revealed; live coding pieces, for example, seem more comfortable with algorithmic textures than other forms of LEO performance. It would appear to me, that the display and sonification of performing actions "pressed together in simultaneous activity" is indeed the ultimate goal of much LEO music, and this goal determines musical form more than does the technology itself. For some, this an affirmative outcome: after all, why have machines determine musical form? For me, it is more a question of whether the kinds of forms we might imagine groups of machines and users jointly creating are actually being brought into fruition. The medium suggests a spectrum of ways to intervene in real time on digital sound projection, but in practice, the results are less varied.

4. TEXTURE IN JARGO'S TABLE

Jargo's Table (JT) does not so much solve these problems as much as suggest ways for my own compositional practice to continue with LEO music given my crankiness. Like many works for LEO, it is an open, improvised design without a score. "Practicing" JT is more about discussing strategies for reacting to changes that other players introduce. As stated, JT leans on the localized sound source model, but in practice, there is a ghostly sense of musical agency as defined by a station location. Sound is associated with an individual station located in space, but three of the four stations cannot make a sound. These machines can only modify sounds once that have been, or are about to be, initiated.

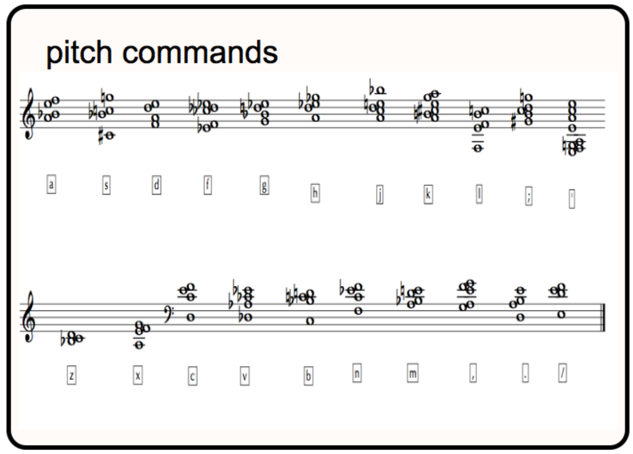

Figure 2. Pitch Server Commands.

Each station multicasts control signals for a single musical parameter to all four machines. One player selects among an array of pitch tables (Figure 2); another selects from a palette of timbres and directs it to a single station, or to pairs, or to all four machines (Figure 3); another selects a sequence of durations, pulses, and/or onset delay values and directs these to particular machines (Figure 4); the fourth selects which machine, or pairs will sound an arbitrary number of note events plus whether the pitch material selected by the Color Player will be *ordered* or *unordered* (Figure 5). I call this fourth machine "Texture," and its critical, conductor-like role threatens to compromise what I hoped would be a model of equal, interdependent performer-composers. When separating parameters for individualized control, localization becomes a decisive factor in determining the heard context of the other parameters.

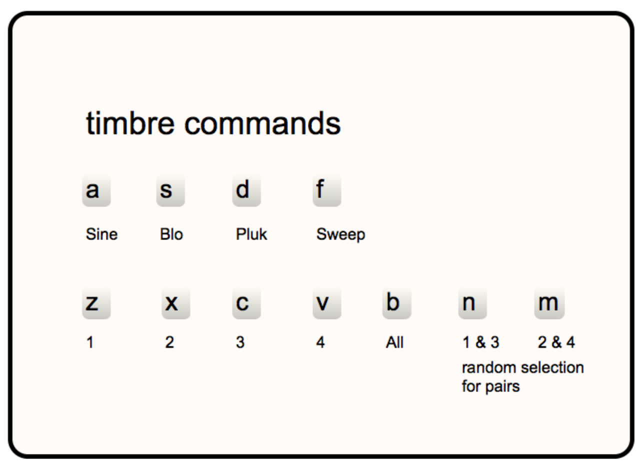

Figure 3. Timbre Commands.

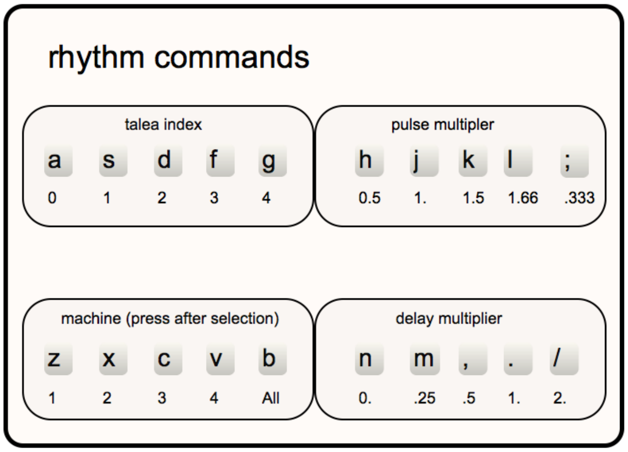

Figure 4. Rhythm Commands.

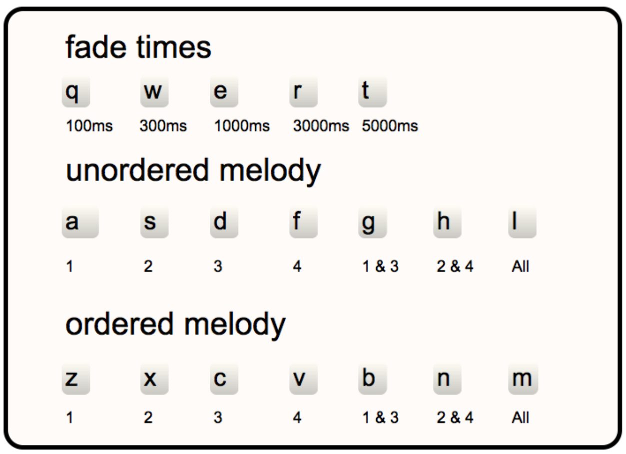

Figure 5. Texture Commands.

Linking the choice of ordered and unordered melody with localization brings the potential for what's conventionally called "free texture," changeable on the fly. If, for example, the Texture Player chooses Ordered Melody and the Rhythm Player chooses a Delay Multiplier, imitative textures result. If, on the other hand, the Timbre Player chooses one timbre for three machines and another for the one, *and* the Texture Player assigns Ordered Melody to the single and Unordered Melody to the other three, a homophonic texture is implied.

Theorists have struggled to pin down the ways in which separable parameters of music combine in seemingly patterned ways in musical forms; these are typically referred to as "texture." Recent theoretical work on the subject defines texture in terms of "timbre, density, and the relative salience of each melodic line," the recognition of which would depend in part on a consistent treatment of the "registral span" of constituent elements. [9] Paul Lansky distinguishes the predominance of "sound texture" versus "harmonic texture" in a particular context as resulting both from the degree of separation of the parametric elements *and* the degree to which profound changes in any of them would disrupt the textural consistency of a given texture. [10] The localization of sound/activity in physical space as a form-giving element is yet another factor determining texture; e.g. imagine a hocket represented in mono. [11] For composers, one of the most open and evocative aspects of musical texture is derived from how difficult it is to understand what texture is in the first place! Indeed, the importance of texture in new music is in part due to the malleability of the concept. In music that is not as overtly textural as repetitive "phasing" structures (minmalism) or layered timbral sound-blocks (aleatoric textures), both localization and the ordered/unordered modality of the constituent voices help to clarify the formal function (melodic versus harmonic) of its role in the texture.

CONCLUSION

JT provides a paradigm for networked LEO music in which each composer-performer has a constrained access to a database otherwise shared by each laptop station. I am presently working on a double quartet in which each quartet shares a database exclusive to that quartet. While there are, theoretically speaking, a limited number of musical parameters, there are a great number of ways to parse the control of these parameters to a variety of player-stations.

Composers and theorists have long imagined a compositional "space" as a collection of variables, possibilities, and constraints from which the work emerges as a single trajectory through possible paths. Networked LEO practice allows for a group exploration of such compositional spaces: for me, the more unique, and idiosyncratic these spaces can be, the better. Composition is both personal and communicative; pieces designed like JT create a kind of listener-performer that can join me on what are usually solo journeys through pre-compositional spaces. J. L. Alty linked the compositional space metaphor with the idea of "states" in artificial intelligence when he describes the musical work "as a movement through a set of interconnected states from the beginning of the work to the end." [12] He went on to describe "planning horizons" at various time scales, from the short-term decision among particular rules and patterns to long-term constraints shaping a "compositional voice" throughout a lifetime's creative practice. A key component to the future of LEO music is the cultivation of compositional voices that might not necessarily re-draw technological boundaries but settle within them in order to sustain and refine in infinite detail a role for creative engagement.

5. REFERENCES

[1] Wang, G., and P. Cook, "ChucK: A concurrent, on-the-fly audio programming language," Proc. ICMC, 2003.

[2] Ogborn, D. 2012 "Composing for a Networked, Pulse-Based Laptop Orchestra," *Organised Sound* 17(1).

[3] Smallwood, Trueman, Cook, and Wang, 2008 "Composing for Laptop Orchestra," *Computer Music Journal* 32(1).

[4] Wang, G., Trueman, D., Smallwood, S. and Cook, P., 2008. "The laptop orchestra as classroom." *Computer Music Journal*, 32(1):26–37.

[5] Atali, Jaques. *Noise.* trans. B. Massumi, (Minneapolis: University of Minnesota Press) 1985.

[6] Cone, Edward T..*Perspectives on Schoenberg and Stravinsky.* Benjamin Boretz and Edward T. Cone, Eds. West Port, CT: Greenwood Press (reprint, Norton), 1972.

[7] Ligeti, Gyorgy, 1960. "The Metamorphoses of Music Form," *Die Reihe*, K. Stockhausen and H. Eimert, Eds, trans by C. Cardew. Bryn Mawr: Theodore Presser, 1965. pp. 5 -11.

[8] Kassabian, Anhid. *Hearing Film: tracking identifications in contemporary Hollywood film.* (New York: Routledge) 2001. pp. 2 –14.

[9] Rozin, Alexnder, "The Analysis and Cognition of Basic Textural Structures," 2010. Proc. *1 1th International Conference on Music and Cognition*, Seattle, 2010.

[10] Lansky, Paul. "Texture," *Dictionary of Contemporary Music.* Ed. Vinton, J. (London: Thames and Hudson) 1974. pp. 741-7.

[11] Stiefel, Van. 2002. *Maison Vague: The space metaphor in contemporary music* (PhD thesis, Princeton University).

[12] Alty, J. L. 1995. "Navigating through Compositional Sapce: The Creativity Corridor," *Leonardo.* 28(3) pp. 215-219.

THE MINC PLAYER MANAGEMENT PROJECT

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ABSTRACT

An open-source project designed to handle management of at-will participation by users/players of mobile devices in the context of a musical ensemble is presented. The first phase of the project is a JavaScript implementation running in MaxMSP. (The second phase will be a custom MaxMSP external object.) The implementation provides a simple, robust, and expandable solution for scenarios in which a musical work allows for participants to join and leave the ensemble over a local wireless network during a performance. As an additional core feature, it implements support for a user/player waiting list in cases where the demand exceeds the upper limit of a given system. We present our code as one possible solution that can be easily used and/or adapted by others who wish to build similar audience-as-performer systems.

Author Index

Keyword Index