

## **STANFORD LAPTOP ORCHESTRA (SLOrk)**

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### **ABSTRACT**

In the paper, we chronicle the instantiation and adventures of the Stanford Laptop Orchestra (SLOrk), an ensemble of laptops, humans, hemispherical speaker arrays, interfaces, and, more recently, mobile smart phones. Motivated to deeply explore computer-mediated live performance, SLOrk provides a platform for research, instrument design, sound design, new paradigms for composition, and performance. It also offers a unique classroom combining music, technology, and live performance. Founded in 2008, SLOrk was built from the ground-up by faculty and students at Stanford University's Center for Computer Research in Music and Acoustics (CCRMA). This document describes 1) how SLOrk was built, 2) its initial performances, and 3) the Stanford Laptop Orchestra as a classroom. We chronicle its present, and look to its future.

### **1. INTRODUCTION**

The Stanford Laptop Orchestra (SLOrk) is a large-scale, computer-mediated ensemble that explores cutting-edge technology in combination with conventional musical contexts - while radically transforming both. Founded in 2008 at Stanford University's Center for Computer Research in Music and Acoustics (CCRMA), this unique ensemble comprises more than 20 laptops, human performers, controllers, and custom multi-channel speaker arrays designed to provide each computer meta-instrument with its own identity and presence. The orchestra fuses a powerful sea of sound with the immediacy of human music-making, capturing the irreplaceable energy of a live ensemble performance as well as its sonic intimacy and grandeur. At the same time, it leverages the computer's precision, possibilities for new sounds and for fantastical automation to provide a boundary-less sonic canvas on which to experiment with, create, and perform music.

Offstage, the ensemble serves as a one-of-a-kind learning environment that explores music, computer science, composition, and live performance in a naturally interdisciplinary way. It also provides a unique research platform for exploring new performance paradigms, instruments, and novel expressive uses of technology.



**Figure 1.** SLOrk classroom; SLOrk speaker arrays.

### **2. AESTHETIC AND RELATED WORK**

The Stanford Laptop Orchestra embodies an aesthetic that is also central to the Princeton Laptop Orchestra [8, 9, 10, 12], or PLOrk – the first ensemble of this kind, while fully leveraging CCRMA's natural intersection of disciplines (Music, Electrical Engineering, Cognition, Physical Interaction Design, Performance, and Computer Science, etc.) to explore new possibilities in research, musical performance, and education.

Recently, more laptop-mediated ensembles have emerged, including CMLO: Carnegie Mellon's Laptop Orchestra [3], MiLO: the Milwaukee Laptop Orchestra [1], the Worldscape Orchestra [6], with recent and upcoming ensembles in Tokyo, Moscow, Oslo, and Bangkok. While these may be quite different from that of SLOrk (and PLOrk), it is consistent with the idea that a laptop orchestra is meant to be open-ended, much like the computer itself, and awaits human creativity to shape it for expressive use.

### **3. BUILDING AN ENSEMBLE**

#### **3.1. Pre-Laptop Orchestra**

In the beginning of 2008, a one-time course was offered at CCRMA, titled "Pre-Laptop Orchestra", with the ultimate goal of building SLOrk into a fully functioning ensemble and platform, and in time for the full course in Spring 2009, titled "Composing, Coding, and Performance with Laptop Orchestra". Over 30 individuals participated, including CCRMA PhD, Masters, and undergraduate students. The Pre-Laptop Orchestra operated on several concurrent tracks. Firstly, the desire to maximize mobility motivated a campaign to design SLOrk speaker array from

the ground up. Secondly, it was necessary to finalize the hardware specification for the ensemble and address the practical aspects of how each SLOrk station works. Lastly, the software architecture for SLOrk was designed to accommodate the special needs of the ensemble.



Figure 2. Making speaker arrays from salad bowls.

### 3.2. Speaker Array Design

SLOrk makes use of twenty multi-channel speaker arrays. Each speaker array consists of six discrete car audio speakers, six onboard amplifiers, a hemispherical wooden enclosure, six ¼” mono TS audio jacks, a single ON/OFF switch, and requires a single 12V DC power supply. The overall design goal was to provide an acoustical “point source” immediately adjacent to a performer in a lightweight and mobile fashion. This strongly couples each laptop performer with their own localizable sound and more closely emulates typical acoustical instruments in traditional ensembles.



Figure 3. Building hardware and software.

The main design and building process can be separated into three categories: enclosure, amplifier, and external interface. The enclosure consists of a commercially available wooden hemisphere (e.g., IKEA salad bowl) and wooden base plate, structurally holding five speakers on a 360-degree periphery with a single speaker pointing up. The speaker amplifier is housed within the enclosure and consists of six discrete amplifiers in the form of three modified stereo Sonic Impact 5065

Generation 2 T-Amps. The speakers, amplifier, and external audio inputs are connected via six discrete audio inputs and the necessary power connections.

To effectively approximate such an acoustic point source, numerous speaker enclosure shapes were explored including spherical, tetrahedral, and hemispherical. While the spherical and tetrahedral designs were interesting in their own regards, practical issues limited the feasibility of such enclosures, ensuing the hemispherical design. Additionally, commodity hemispherical enclosures (salad bowls) greatly reduced enclosure cost and construction and arguably improved the sound quality and aesthetic.



Figure 4. A finished speaker array; single station.

When considering the speaker amplifier, first designs included external audio amplifiers (pre-built and home assembly kits) housed within considerably small external enclosures, but after much deliberation even small external amplifiers were considered undesirable. Because of this, compact commercially available audio amplifiers were used with slight modification to additionally reduce the physical footprint of the amplifier. The faceplate was then straightforwardly designed to connect the modified amplifiers to the six speakers and audio inputs. For a more thorough description and step-by-step guide to the building process, please visit: <http://slork.stanford.edu/speakers/>

### 3.3. Integration

In addition to speaker arrays, each of the twenty laptop stations contains the following: 13” black MacBook MOTU Ultralite firewire audio interface, IKEA breakfast tray (for holding the laptop), meditation mats and pillows (where the player sits), and custom 6-channel audio snakes.

Shared among the ensemble are the following: 802.11 wireless switch, 802.5 wired gigabit ethernet switch, 4 power conditioners, 10 TriggerFinger MIDI interfaces, 8 MIDI keyboards, 20 joysticks, Microphones (Shure SM-57 and Shure KSM-237), and storage bins. For software, the ensemble uses ChucK [11] as its primary vehicle for instrument mapping, sound generation, and teaching, while always remaining open to using any other software. SLOrk also uses the Small Musically Expressive Laptop Toolkit for rapid prototyping of physical laptop instruments [4]. Subversion (SVN) is used for version control, synchronizing a central repository of instruments and pieces across the ensembles.

## 4. PERFORMANCES

The Stanford Laptop Orchestra commenced its inaugural term in Spring 2008, offering a number of performances, taking place as part of the “Composing, Coding, and Performance for Laptop Orchestra” course. This section describes some of the performances and the ideas associated with each.



**Figure 5.** Stanford Laptop Orchestra performs onstage and in more intimate chamber settings

### 4.1. Sonic SLOrk Sculptures

The first official concert for SLOrk took place at the New Guinea Sculpture Garden, Stanford University. This performance was the first full-scale outdoors laptop orchestra performance, involving twenty laptop stations. Because of its unique outdoors setting, the group had to figure out solutions to uncommon problems such as acquiring power, sending wireless signals (the switch had to be placed on a high tree branch to gain line of sight to the widely distributed stations), and working with ambient noise. The audience was encouraged to sit close to a station to observe the performers, and even to walk around during the performance to hear the soundscapes generated by the ensemble (Figure 6).



**Figure 6.** SLOrk outdoors; *Pacific Rim of Wire*.

### 4.2. Pacific Rim of Wire

Another major concert performed by SLOrk was the Pacific Rim of Wire, at Dinkelspiel Auditorium, Stanford University. This was an online concert with China, as part of the 2008 Pan-Asian Music Festival. In this first laptop orchestra telematic concert, musicians from SLOrk and the Stanford New Ensemble connected with musicians of Central Conservatory of China in Beijing to perform - in real time via networking - a program that celebrates music, technology, and international collaboration [2] (Figure 6).

### 4.3. SLOrktastic Chamber Music

This concert showcased student-composed works in an intimate chamber music setting. All eighteen pieces showcased in the concert were product of a classroom assignment, and each piece reflected the creativity of the student composer. The following is a brief highlight of some of the pieces presented:

**Clair De Lupe**, by Baek Chang, is a granular synthesis interpretation of Clair De Lune by Claude Debussy. It uses a multigrained granular synthesis ChucK patch, which has now been adapted by other SLOrk works.

**nous sommes tous des Fernando...**, by Robert Hamilton, is an improvisatory work written for the SLOrk using q3osc [5]. A screen projected in front of the hall displays a virtual environment, in which performers control avatars: firing sound-projectiles which bounce or home-in on individual performers, creating sound events with every bounce/collision.



**Figure 7.** Chamber conducting; 20 laptops playing.

**PopcorN**, by Jieun Oh, is a multi-sensory piece that simulates popcorn being popped inside a microwave. Over three minutes, six laptop stations create a ‘pop’ noise, reaching maximum popping frequency and intensity. Once the time is up, a microwave signals the end of the piece – at which point real edible popcorns is brought to the audience to taste (Figure 7, left).

**20**, by Kyle Swenson Spratt and Adnan Marquez-Borbon, involves two performers working through a pile of laptops. The end result is a giant sound-emitting physical sculpture of twenty laptops (Figure 7, right).

## 5. THE SLORK CLASSROOM

A typical SLOrk classroom naturally integrates aspects of composing, coding, and performance. The beginning of quarter is spent exploring existing repertoire to offer new students a sense of what it is like to perform in a laptop orchestra. These sessions spark a lively conversation and lead into the primary coursework: student compositions and performances. These composition assignments give students opportunities to create new pieces, which are then presented and tried out during class in a chamber setting. Finally, performance is an integral part of the SLOrk classroom. During rehearsals, students learn about the interface controls to a given piece, become familiar with

the conductor's gestures, and come to understand the artistic aims of a piece. Through rehearsals students learn to become a sensitive performer, focusing on the quality of the sound generated and striving for high musicality.



Figure 8. SLOrk classroom in action.

## 6. ONGOING AND FUTURE WORK

More recently, the Stanford Laptop Orchestra has been exploring mobile composition and performance paradigms with the Stanford Mobile Phone Orchestra (MoPhO) [13]. The localized sound sources of mobile devices resemble that of the laptop orchestra, while offering a fundamentally different expressive computational platform that is inherently mobile and personal.

In summary, the Stanford Laptop Orchestra presents a large-scale, robust, and long-term platform and meta-orchestra. The challenge is find ways to leverage both the computational power of machines and the expressiveness of humans. The Stanford Laptop Orchestra homepage can be found at: <http://slork.stanford.edu/>

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