

Pro



Stanford Laptop Orchestra (SLOrk): Musical Macs

By Dustin Drvier

When composer/researcher/programmer Ge Wang looks at a MacBook, he sees more than a computer. He sees a versatile platform for creating custom electronic instruments—the perfect tool for transforming lines of code, user input, and even gestures into music.

Wang is the man behind the Stanford Laptop Orchestra (SLOrk), an ensemble of students computer scientists and musicians that uses 20 MacBooks to compose and perform new music. It's an experimental fusion of portable computing and live performance that harnesses the notebook's plug-and-play compatibility, state-of-the-art sensors, and raw processing power.

Chuck had its premiere and is still used with the Princeton Laptop Orchestra (PLOrk), the first orchestra of its kind in the world, which Wang helped establish. When Wang left Princeton for his current position at Stanford, he brought the language with him. Today SLOrk runs Chuck within Mac OS X Leopard, enabling the ensemble's 20 performers to augment the timbre of their MacBook-based orchestral instruments instantaneously.

Building SLOrk
Wang translated SLOrk from the ground up, starting with 20 MacBooks and Chuck. "We got overall great performance out of the MacBook," he says. "Out of the box, the audio latency is very low. Mac OS X is stable, and the system itself just works. It also has a fantastic plug-and-play capability. I can plug in an audio interface and I'm ready to make sound. If you hook up a USB keyboard, drum pad, or joystick, you're ready to use it within seconds. Core Audio in OS X takes care of that interface between software and hardware, which isn't trivial. Without it, we wouldn't be an orchestra."

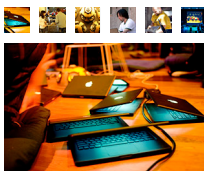
The MacBook also presents SLOrk with an array of built-in input devices and sensors that could be used during a performance. "The MacBook has so much," says Wang. "We look at a MacBook and we don't just see a laptop. It has a keyboard we can use to make music. It has a 2D position sensor [trackpad] that we can use. It has an accelerometer that gives us another control parameter. We have so many options with the MacBook—there wasn't another choice."

After selecting the MacBook as the basis for his orchestra, Wang designed unique speaker systems to give each performer in the orchestra his or her own sonic space. "In an orchestra, the sound doesn't come from a central PA system," he says. "Each instrument emits its own sound. I wanted that same effect with our orchestra." The professor and his students built 20 separate speaker systems out of wooden salad bowls, car speakers, and compact amplifiers. Each sound system has six speakers and six channels of audio," says Wang. "They sound great in concert, and they give each musician his or her own voice."

Mediating Passions
Many musicians compose, perform, and record with their MacBooks, using virtual instruments, spliced audio samples, and MIDI instruments. Wang has a different approach. To him, a MacBook provides an opportunity to craft and manipulate sound directly. It's a philosophy that grew out of a love of both music and computer science. The professor was raised in a musical family and learned to play accordion at an early age. In high school he picked up a guitar and fell in love with heavy metal. He simultaneously discovered a talent for manipulating code, and vowed to fuse his two passions in his career.

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Gallery



SLOrk laptops glowing during a 2008 SLOrk/Princeton Chamber Music performance.

About Chuck

"Chuck is a programming language tailored for generating and making sense of sound," says Wang. "You write straightforward code to experiment with sound and musical ideas on the fly. You can write a little bit of code, hear it, and make some changes. It's an immediate process of actually playing with sound. Chuck is a tool that allows us to do all that from scratch." It may sound complicated, but Wang views that Chuck is so friendly as its monitor. "It's designed to have a shallow learning curve," he says. "It's possible for someone who's never programmed before to start making music within the first 30 minutes."

Crafting Sound

Constructing the SLOrk sound comes both ingeniously and timely. "There was a lot of engineering involved," says Wang. "We used 11-inch wooden salad bowls, and cut the holes for the speakers using drills and hole saws. We did a lot of engineering to get the amplifiers, speakers, and input plate to fit. We capped off the bottom of the units with custom-cut poplar bases. Each one weighs about 15 pounds, so they're very easy to transport. They really turned out to be the perfect sound system for SLOrk."

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Apple Pro feature

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Equipment List

- | | |
|------------------------------------|---------------------------------------|
| Hardware | Peripherals |
| • MacBook Pro | • MOTU Ultralite Audio Interface |
| • MacBook Pro | • Custom six-channel speaker arrays |
| • iPhone | • Subwoofers (various vendors) |
| • Airport Extreme | • Shure SM-57 and KSM-141 microphones |
| Software | • MIDI keyboards (various vendors) |
| • OS X Leopard | • M-Audio Trigger Finger drum pads |
| • Chuck audio programming language | • Logtech Extreme 3D Pro Joysticks |
| | • USB Dance Pads |
| | • Wii Remotes |

Smule

Wang has begun experimenting with music-making applications for the Apple iPhone. In 2008, he co-founded a company called Smule to explore sonic applications on the device; the first product, Sonic Lighter, is now available via the iTunes App Store.

"One of our next apps, Ocarina, lets you play an ocarina on the iPhone by physically blowing into the microphone, using multi-touch to control fingering, and leveraging the accelerometer to modulate the sound. Furthermore, there is a globe visualization that allows the user to listen in on people playing around the world in real time. We aim to push the boundaries of what's possible on the iPhone with sound and interaction."

Useful Links

- | | |
|-----------|----------------------------|
| • SLOrk | • Smule Ocarina iPhone App |
| • Ge Wang | • MHP0 |
| • Chuck | |

Composing the Future

Since its debut in early 2008, SLOrk continues to perform on and off campus, giving students and music fans a chance to experience the ensemble's unique fusion of code and music. Among other projects, the orchestra collaborated on an Internet-based performance with musicians at the Central Conservatory of China in Beijing. The SLOrk ensemble connected to Beijing via the latest internet audio system from SoundWire (another research group at CCRMA, led by the Center's director, Chris Chafe) and jammed with conservatory musicians in real time. It was the first performance of its kind in history. Wang plans to hold more Internet concerts with orchestras across the world, and hopes to meet up with the Beijing musicians—in person—in the future.

But live performances alongside traditional orchestras are just the beginning. Wang plans to find new ways for people to make music with computers and code, taking advantage of emerging technologies to further blur the lines between composition and computers.

Once again, Apple products prove perfectly aligned with the orchestra's aims. For example, Wang says, "There is amazing potential for the iPhone to be a musical instrument, starting with the combination of multi-touch, accelerometer, and portability. I think there are many unique possibilities there for music-making in the future," he adds. SLOrk could also incorporate other iPhone and notebook features such as touch screens, pressure sensors, light sensors, and built-in video cameras.

"I'm very excited about the future and how we're going to explore new ways of making music," says Wang. "We're going to experiment with sound in ways that we've haven't even imagined. We're going to make it creatively, quickly, and expressively—and we're going to use the Mac."

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Unusual Interfaces

Using a custom sound system, the SLOrk ensemble can generate a wall of sound to rival any traditional orchestra. The way it generates that sound, however, is very different from anything Mozart or Bach envisioned. Each musician in SLOrk creates his or her own instrument and interface using Chuck. Wang conducts the orchestra, giving the musicians visual cues. The ensemble is synchronized with an electronic metronome that broadcasts its signal to each notebook via Wi-Fi.

"Each musician uses their own interface to play their part," says Wang. "Some use the keyboard, others use the trackpad like a violin bow. We have musicians using USB controllers, joysticks, Wii Remotes, anything. Some of them are generating sound by manipulating Chuck code in real time."

Wang has also tapped into MacBook sensors to augment sound during a performance. "We use the built-in accelerometer a lot in our compositions," he says. "You'll often see me signaling to the musicians, asking them to tilt their notebooks to one side, forward or backward. We can map those changes in position and use them to change sound."

Every MacBook in the ensemble is linked to its sound system through a MOTU Ultralite stand-alone audio interface. "The Ultralite takes the digital signals from the Mac and translates them to analog signals for the sound systems," says Wang. "It also has volume controls that we use during our concerts. With this setup we have a number of options at our disposal. We're able to have really optimum performances."

A Diverse Ensemble

SLOrk performers are equal parts musician and computer scientist. Some members are obsessed with code, others are hooked on sheet music. All of them joined SLOrk to do something different with electronic music. "The ensemble is really two classes in one," says Wang. "There's programming, there's computer music, there's composition and arrangement, and on top of it all it's a performance class. The best part is there are no requirements to join, just an excitement about music."

With the MacBook and Chuck, Wang bridges the gap between programming and music, giving all his students a chance to create and perform. "We teach the programming tools and the music together," he says. "If a musician comes into the class with no programming background, they learn it as part of class. Unlike more traditional programming courses, the end goal is to make an instrument, make a piece, and perform it. Programming just becomes a natural tool in the process."