

"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. It has an accelerometer that gives us another control parameter. We have so many options with the MacBook—there wasn't another choice."



## Stanford Laptop Orchestra (SLOrk): Musical Macs

### Unusual Interfaces

Using its custom sound systems, 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 truly spontaneous performances."

### 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 seem 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.

### Equipment List

#### Hardware

MacBook  
MacBook Pro  
iPhone  
Airport Extreme

#### Software

OS X Leopard  
Chuck audio programming language

#### Peripherals

MOTU UltraLite Audio Interface  
Custom six-channel speaker arrays  
Subwoofers (various vendors)  
Shure SM-57 and KSM-141 microphones  
MIDI keyboards (various vendors)  
M-Audio Trigger Finger drum pads  
Logitech 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 newest 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  
Ge Wang  
Chuck

SMule Ocarina iPhone App  
MoPhO

**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."

"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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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."

**Mac Pro Profiles Stanford Laptop Orchestra (SLOrk)**

<b>Macs</b>	<b>Accessories</b>	<b>Applications</b>	<b>Markets</b>
MacBook Air	Magic Mouse	iLife	Business
MacBook Pro	Magic Trackpad	iWork	Creative Pro
Mac mini	Apple Wireless	iBooks Author	Education
Mac mini server	Keyboard	Aperture	Students
iMac	Thunderbolt Display	Final Cut Pro	Science
Mac Pro	AirPort Express	Motion	<b>Support</b>
<b>Considering a Mac</b>	AirPort Extreme	Compressor	AppleCare
<b>Why you'll love a Mac</b>	Time Capsule	Logic Pro	Online Support
Compare all Macs	OS X	MainStage	Telephone Sales
FAQs	OS X Mountain Lion	Remote Desktop	Genius Bar
Try a Mac	OS X Server	Safari	Workshops
		QuickTime	One to One
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