"The Birth and Rise of the Laptop Orchestra"

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https://artful.design/
THE BIRTH AND RISE OF THE LAPTOP ORCHESTRA!

DIRECTLY OUT OF PERRY AND DAN’S WORK ON EMBODIED INTERFACES AND SPEAKER ARRAYS, THE LAPTOP ORCHESTRA PUSHES THE IDEA OF ELECTRONIC CHAMBER MUSIC TO A NEW (C)OLOGICAL EXTREME. NOT ONE, BUT AN ENSEMBLE OF EMBODIED INTERFACES WITH HUMANS IN THE LOOP!


LAPTOPS? ORCHESTRA? NE’ER THE TWAIN SHALL MEET! AND YET...

HOW DOES IT CHANGE THE WAY WE COMPOSE...

...AND DESIGN INSTRUMENTS AND CRAFT LIVE PERFORMANCES?

...THIS STRANGE PAIRING MAKES IT ALL THE MORE INTRIGUING!

SCOTT SMALLWOOD

AND FIND A GOOD BALANCE BETWEEN HUMAN AND TECHNOLOGY?

DAN TRUEMAN

PLORK’S WEST COAST SIBLING, STANFORD’S SLORK WAS FOUNDED THREE YEARS LATER IN 2008.

THE LAPTOP ORCHESTRA IS A LARGE-SCALE, COMPUTER-MEDIATED PERFORMANCE ENSEMBLE, DESIGN LABORATORY, AND CLASSROOM, EXPLORING A RADICAL INTERACTION OF SCIENCE AND TECHNOLOGY WITH ART, DRAWING FROM BOTH CONVENTIONAL AND CUTTING-EDGE PRACTICES.

SLORK IN BEIJING 2004

ENSEMBLES IN THIS MEDIUM CAN BE COMPRised OF MORE THAN 20 LAPTOPS, HUMANS, AND...

...CUSTOM MULTI-CHANNEL HEMISPHERICAL SPEAKER ARRAYS...

...DESIGNED TO PROVIDE EACH COMPUTER META-INSTRUMENT AND HUMAN PERFORMER WITH THEIR OWN SONIC IDENTITY AND PRESENCE.

THE LAPTOP ORCHESTRA IS CAPABLE OF FUSING A POWERFUL SEA OF SOUND WITH THE IMMEDIACY OF HUMAN MUSIC-MAKING, ATTEMPTING TO CAPTURE THE ENERGY OF A LIVE ENSEMBLE AS WELL AS ITS SONIC INTIMACY...

...IN WHAT WE THINK OF AS A FORM OF ELECTRONIC CHAMBER MUSIC.

THE LAPTOP ORCHESTRA EMBODIES MANY OF THE IDEAS WE’VE ENCOUNTERED—RE-MUTUALIZATION, BODY, CO-DESIGN, INTERFACES AS EXTENSIONS...
That the notion of a "Laptop Orchestra" is seemingly paradoxical. One of my primary motivations for creating one, the pairing of these two inventions is perhaps obvious only because of its apparent impossibility. One is an almost archaic institution whose continued existence is something of a miracle, the other is a technological newcomer that has become commonplace and seems likely to be with us, at least in some form, for quite some time...

One serves to perform primarily European music from centuries ago, while the other is a convenient tool for editing text, cranking numbers, browsing the Web, and checking e-mail. Never the twain shall meet.

**The Orchestra vs. The Laptop (in performance)**

- **LARGE**
  - Typically lives in a reasonably large performance hall with good musical acoustics
  - Sound is net sum of many relatively proximal instruments in this hall
  - Divided into sections according to the nature of these instruments
  - Instruments typically take decades to master, and have been under refinement for even longer, sometimes centuries
  - Usually conducted

- **Laptop**
  - Typically used alone
  - Plans in all sorts of spaces: bars, clubs, sometimes concert halls
  - Sound is typically amplified through a centralized PA system
  - Instrument design is constantly in flux, sometimes even generated during the actual performance (live coding), often created by the player
  - Mastery of instruments can take a few minutes or much longer
  - "What? A conductor?"

The Laptop Orchestra medium was designed with the ethos...

"Borrow what makes sense. Invent the rest."

**The Laptop Orchestra**

- Typically between 4 (quartet) and 20 (full ensemble) performers in size
- Each human performer is paired with a meta-instrument, so called because it's a laptop station that can be designed into different and more specific instruments
- A meta-instrument consisting of a laptop, multi-channel audio interface, and -- crucially -- a multi-channel hemispherical speaker array
- Sound is local and proximal to each instrument and player
- Instruments are often designed on a case-by-case basis, tightly tailored to each work in question, as bespoke experiences for each piece
- The notion of playing the instruments are as varied as the instruments
- Formats of pieces range from free-form or structured improvisation to rigidly scored pieces; no prescribed limitation on types of music (e.g., genre)

Typical setup for each meta-instrument in the stanford laptop orchestra:

- **Hemispherical Speaker Array** keeps sound local to the instrument
- **Audio Interface** multi-channel audio signal to speaker array
- **Meditation Pillow** might as well be comfortable
- **Meditation Mat** we sit close to the ground
- **Breakfast Tray** for holding the laptop

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For me, the allure of the laptop orchestra is a design lab where the instruments we build and the works we compose are “deployed” in concert settings where, aesthetically, the rubber meets the road.

Central to the laptop orchestra is the idea of designing different types of musical interactions that bridge the traditional human-centric aspects of music-making and the unique (and less understood) possibilities of technology.

The sound of a violin does not naturally come out of speakers around you, but rather from the artifact itself...

Our speaker arrays are direct descendants of research that Perry and Dan conducted in the 1990s. Much like the Bossa hemispherical speaker arrays approximate outward-radiating sound sources, emulating the way acoustic instruments radiate sound.

They provide a sonic presence and the impression of a physical artifact making the sound in proximity to you, in stark contrast to the disembodied sound from speakers that surround you.

Independent addressability means we can send different sound to each speaker, making possible techniques for spatialization and effects.

Multiplies out to an ensemble of such sound sources, this embodied approach changes the way we design interfaces and write music.

6 speakers 5 around 1 facing up enclosures -- IKEA salad bowl (that's right, salad bowls)

These things weren't exactly off-the-shelf, so we had to design and build them from scratch. Here is how we built ours for $20k...

For each design, a first-order sanity check:

Does the end product justify the technology? Does it do at least one thing that can be achieved by no other means? Does the design use the medium to support the right interplay between technology and humans?

If it fails any of these checks, then perhaps the design, as it stands, isn't that interesting or shouldn't use the technology. Design is cognizant of specifics of the medium, and we try to see humans and computers as two fundamentally different types of entities, each with built-in advantages and limitations.

Computers vs. Humans:

- No inherent notion of intention or aesthetics
- Follow clearly defined instructions and logic
- Capable of precisely carrying out sequences of simple operations
- Can synthesize sounds to specification
- Can be networked

Good design embraces each side for what it is. Here, the medium is the mixture of computers and humans.
ADVENTURES IN BUILDING THE STANFORD LAPTOP ORCHESTRA!

STEP 1: GET SALAD BOWLS

In the California sun, on the steps leading up to CCRM. A.

C.R.M.M.A.

IT BEGAN WITH A TRIP TO THE LOCAL IKEA TO PRODUCE 25 WOODEN SALAD BOWLS.

SALAD BOWLS

READY TO DRILL!

I WORKED OUT THE SCHEMATIC!

LET’S DO THIS!

STEP 2: DRILL!

Measure and mark the centers of speaker locations.

WITH 20 HEMIs AND 6 CHANNELS EACH, WE HAVE TO DO THIS 120 TIMES!

KzzzzNNNNNhhhNZNN

WITH HOLESAWS BURNED OUT IN THE PROCESS.

ANOTHER ONE DONE...

...117 MORE TO GO.

STEP 3: INSTALL SPEAKERS

AND UNFORESEEN ISSUES AROSE...

Reed, Chris, Nick, Lawrence, Diana, David

IT WAS SPRING BREAK 2008, WHILE MANY PARTIED ON BEACHES ELSEWHERE, A SMALL GROUP OF DEVOTED BUILDERS HAD DIFFERENT PLANS.

YEAHHH!!!
Uh, the speaker drivers have corners slightly larger than the holes...

Drilling, drilling, drilling.

Okay no problem! We'll just grind some grooves until things fit!

Wuh that's less than spectacular...

Several rotary sanders met their demise in the process...

Leading to some manual filing...

The measuring, drilling, and filing went well into the night...

They fit!

The salad bowls' new grooves!

Soon thereafter, we had our salad bowl speaker enclosures.

Gotta make 'em look nice and feel smooth...

Late night, at Stanford's Product Realization Lab...

Step 5: Cut and route base plates

The base plates are cut from large sheets of poplar we got from a hardware store. They were routed for a smooth finish.

No one in the audience will ever discern this detail, but it was important to us...

Step 4: Make things fit

The next day...
Meanwhile, a parallel team worked on the electronics and circuitry.

Tinker, wire, solder, fit...

HMM...

Prototypes of various form factors and sizes were built!

NOPE...

... hear anything?

Let’s check the wires again.

Where is that other amp circuit?

Maybe this switch will fit better...

How could this not work?

For the next two weeks, Cora’s Max Lab (named after Max Mathews) transformed into an around-the-clock venue for soldering, circuit bending, drilling, cutting, gluing, experimenting, assembling the laptop orchestra.

Each hemispherical speaker array (or “HEMI”) houses three stereo Class-D “TAMP” amplifiers wired together, for a total of six channels each.

We drilled holes in metal strips through which we installed audio jacks.

Multiplied by 20 HEMIs for a total of 120 channels.

A view behind the strip...

Drawer handle for carrying the HEMI.
**STEP 4: ASSEMBLY!**

Enclosures, speakers, amplifiers, wires, switches, jack panels: all ready to be put together!

**STEP 5: INSTALL SOFTWARE!**

Okay, we gotta get these laptops configured with software — programming environments Chuck (for audio and interaction), Processing (for graphics), and C++ (for low-level system I/O).

Juan Cristóbal

We'll need a reasonable way to synchronize and track musical instruments (code, audio, data, scores) across all machines...

...Ham, and also some memorable names for these machines.

Later that evening...

We've just named all the machines after food. Guess whose idea that was?

**24'' CAR SPEAKER FRIERES INSTALLED AND WIRED**

I can't believe this ensemble goes live in two weeks!

I better cut and stop these wires faster...

I'd like to order six "King Kong" pizzas!

Hey John!

Get this place is hoppin'!

Connect everything up and seal the enclosure!

4/10/09
STEP 9: TEST-DRIVE

BEST WAY TO TEST A LAPTOP ORCHESTRA: MAKE MUSIC WITH IT!

FROM CONCERT HALLS...

TO AN OUTDOOR SCULPTURE GARDEN...

MEH THIS LAPTOP GOES TO ELEVEN.

TO INTIMATE CHAMBER MUSIC SETTINGS...

WHERE WE DEPLOY FEWER STATIONS...

...AND THE AUDIENCE SITS AMONG THE ENSEMBLE.

ZZZ

AND FROM CALIFORNIA TO BEIJING...

A LEX

RO M A N

H A N A

NI HAO

...WITH A NEW GENERATION OF SLOKKERS AT THE STANFORD CENTER AT PEKING UNIVERSITY!

SUMMER 2014

WE CREATED NEW WORKS INSPIRED BY THE SOUNDS, CULTURE, AND PEOPLE OF BEIJING...

AND PERFORMED IN THE MIST...

K I T T Y

BEIJING CAN BE GORGEOUS, ON DAYS WHEN THE SUPER SMOG LIFTS...
STEP 10: DESIGN NEW WORKS!

Indeed, we usually don’t design general-purpose instruments and then write music for them, but rather we start with an idea for a piece, and then work backwards to invent the instrument(s) specifically for that piece, or we co-design the piece with the instrument(s). It’s a great way to discover what features the interface actually needs!

A C-MAJOR CHORD DRONE CARpets THE SOUNDSCAPE AND RAMPS UP INTENSITY OVER THE COURSE OF THE PERFORMANCE

CHoICES OF WASES: ONE, TWO, OR THREE, RESULTING IN ALGORITHMICALLY GENERATED MELODY FRAGMENTS

A TOTALLY DIFFERENT PIECE, AND INSTRUMENT

ON THE FLOOR (2005)

BY SCOTT SMALLWOOD

YOU WILL NOTICE WHEN YOU WALK INTO A CASINO THAT THE MACHINES ARE ALL TUNED TO THE SAME KEY: A C-MAJOR CHORD. THIS CHORD FLOATS AROUND THE SPACE, IN AND OUT OF EVERY CREVICE, CONSTANTLY ARTICULATING HUMMING, DRONING, TWITTERING, ECHOING, SOMETIMES INCORPORATING SNIPPETS OF MELODY. THIS HAPPY DRONE SOOTHES THE NERVOUS CUSTOMERS AS THEY SLOWLY DROP THEIR MONEY INTO THE MACHINES. THEY CREATE A SEA OF C-MAJOR, EACH AND EVERY ONE OF THEM, PRESSING BUTTONS ON THE MACHINES, CREDIT AFTER CREDIT, ALL DAY AND ALL NIGHT.

As part of the theatrical gesture of this performance, players continue playing until they lose all their credits, at which point they physically get up and slowly walk off the stage...

THE INSTRUMENT INTERFACE IS A MOCK SLOT MACHINE, WHERE THE PLAYERS MAKE WAGES OF ONE, TWO, OR THREE VIRTUAL COINS (CHOICES REPRESENTED AND VISUALIZED BY COLORED SPHERES). BY PLAYING THIS GAMBLING SIMULATION, THE ENSEMBLE RECREATES THE SOUNDSCAPE OF A CASINO.

THE CONDUCTOR (A.K.A. “THE HOUSE”) SURVEILS ALL THE PLAYERS FROM A CENTRAL MACHINE AND CAN REMOTELY CHANGE THE ODDS OVER THE COURSE OF THE PERFORMANCE (WHICH ALSO HELPS TO ENSURE THE PIECE ENDS ON TIME)

I AM VIRTUALLY BROKE!

THE PIECE ENDS WHEN EVERYONE LOSES THEIR VIRTUAL MONEY!

REMAINING GONGS FOR PLAYER

NON-SPECIFIC GAMELAN TAIKO FUSION (2005)

BY PERRY R. COOK & GE WANG

This piece is an experiment in human-controlled but machine-synchronized percussion ensemble. Performance variables include: sounds are temporally positioned in patterns by each player (and are synchronized by network across the ensemble), and the piece gradually transitions from tuned bell timbres to drums as the texture and density grows and flows according to instructions conveyed by a conductor.

Each instrument is part of a networked step sequencer that precisely synchronizes all the machines, leaving the player to construct and evolve the musical patterns on a discrete temporal grid.

A conductor signals the density (“wicked sparse” to “very dense”) and timbre (which colors to use) in the pattern. Each player is constructing a conductor holds up pieces of the score.

A KAZET PRINTER. THE SCORE SHEETS ARE PRINTED LIVEn THE PLAY DURING THE PERFORMANCE, FURTHER INPECTING THE IMPROVISATIONAL NATURE OF THE PIECE.

ENSEMBLE: OCCASIONALLY ALSO INCLUDES ACOUSTIC BELLS AND DRUMS

INTELLECTUALIZED PATTERN CREATION

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**DRONE (2005)**

*by Dan Trueman*

Some works employ more physical gestures than others...

**Using accelerometers** (sudden motion sensors intended to protect mechanical harp drives in the event of, well, sudden motion) built into the laptops, the players introduce subtle adjustments to rich (if simple) additive synthesis algorithms in an effort to create ripet-arpeggio-like patterns, a rich, penetrating drone arises with intricately shifting timbres and harmonics created by the slight controlled detuning between all the machines.

The conductor shapes the trajectory of the performance.

**Conducting signal**

- Signal number (1-8)
- Point directionally
- Open arm forward/back
- "Cradle", rock left/right
- "Sprinkle"
- "Mimic"*

**Resulting player actions**

- Choose base pitch of drone
- Move mouse cursor to change timbre
- Tilt laptop forward/backward to control intensity
- Tilt laptop left/right: listen, make interesting beating patterns, randomize one or more parameters, continue until next gesture
- Once this mode is signaled, each player plays when cue; mimicking and embellishing on gesture of previous player

**Section A**

We convey numbers using hand gestures!

**Section B**

"Mimic" only; one player at a time, as cue'd by conductor.

**Section C (or A')**

Return to section A, and (1) riff on a yet-unexplored fundamental pitch, (2) the loudest point in the piece occurs in this section, (3) commit to a particular timbre and fundamental and fade out on it.

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**20 (2008)**

*by Adnan Marquez-Borbon and Kyle Spratt*

In this work for 20 "unplugged" laptops (and only 2 human performers), each laptop is equipped with a program that captures the incoming sound from the microphone and plays it out on the onboard laptop speakers. The laptops are introduced, one-by-one, into a physical configuration of continuous mutual audio feedback: the physical laptop screens are used as a crude low-pass filter for the sound, adding an additional functional and visual control element.

It is about the independence of sound and its behavior once liberated from human control.

A smaller, more intimate setting is crucial to perceive the spatialization of sound.

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The relative positions of laptops and the angles of their screens (which filter the sound) have a pronounced effect on the overall mix.
**TWILIGHT (2013)**

**BY GE WANG**

Inspired by the classic science fiction short story “Twilight” by John W. Campbell (published in 1934, under the pseudonym “Don A. Stuart”), this piece rummages not on the dawn, ascension, nor triumph of the human race, but on our possible demise. Set seven million years in the future, this end is not one of annihilation through war, nor from famine or disease, but a golden decrescendo of defeat brought on by the gradual, peaceful, but unstoppable usurping of technology and machines — and the loss of humankind’s curiosity and sense of wonder. From the original text:

“Twilight — the sun has set, the desert cut beyond, in its mystic, changing colors, the great, metal city rising straight-walled to the human city above, broken by spires and towers and great trees with scented blossoms. The silvery rose glow in the paradise of gardens above.”

**MOVEMENT ONE**

**THE DEAD CITY**

“And all the great city-structure throbbing and humming to the steady gentle beat of perfect, deathless machines built more than three million years before — and never touched since. That time by human hands, and they go on. The dead city, the men who have lived, and hoped, and built — and fell to leave behind them those little men who can only wonder and look and long for a forgotten kind of companionship they wander through the vast cities their ancestors built, knowing less of them than the machines themselves.”

The design brings together a classic science fiction narrative, a physical metaphor (pulling a sound out of the ground), and a synthesis algorithm (granular synthesis).

**THE METAPHOR**

The primary interaction in movement one is based on the abstract idea of pulling a sound out of the ground.

The interaction is mapped onto granular synthesis, such that the vertical position directly controls the playback position of any input sound effectively “scrubbing” through the sound. If the motion stops halfway, the sound will continue, but it is frozen at the current playback position. Granular synthesis makes this effect seem smooth and timeless.

**GRANULAR SYNTHESIS**

Chops up an input sound into tiny (10-100 ms) windowed particles (called grains), transforms them (in pitch, density) and reconstitutes them into impressionistic sound clouds.

The interaction is mapped onto granular synthesis, such that the vertical position directly controls the playback position of any input sound effectively “scrubbing” through the sound. If the motion stops halfway, the sound will continue, but it is frozen at the current playback position. Granular synthesis makes this effect seem smooth and timeless.

**TRANSFORMATION**

The resulting effect is a sense of sound becoming stuck in time, allowing us to “scrub” through it with our gestures.

**OVERLAP-ADD SYNTHESIS**

It creates the haunting sound of the dead city, a sonic maelstrom of humming, scrape-sounds, and scraping machines, long liberated from human design and maintenance.

**THE ENSEMBLE MIRRORS THE CONDUCTOR’S MOTION, MOVING IN UNITY GIVING VOICE TO A CITY OF MACHINES.**
Dawn turns to dusk. The ensemble -- who earlier assumed the roles of machines and the city spires -- now represent humanity, lying down to sleep physically, metaphorically...

...a song of longings.

Movement Two

A Song of Longings

"And the songs, those tell the story best, I think: little, hopeless, wandering men and vast unknowing, blind machines that started three million years before -- and just never knew how to stop, they are dead -- and can't die and be still..."