intelligent instruments LAB

Cling for live coding music and musical instruments

Jack Armitage

Postdoctoral Research Fellow

Intelligent Instruments Lab

CERN Compiler Research Group meeting, 9th June 2022

Overview

- Intelligent Instruments Lab
- The artistic live coding community
- Artistic uses of Cling
  - Musical live coding
  - Embedded digital musical instrument design
- Reflections on scientific & artistic programming

intelligent
instruments LAB

Understanding 21st century AI through creative music technologies.

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European Research Council

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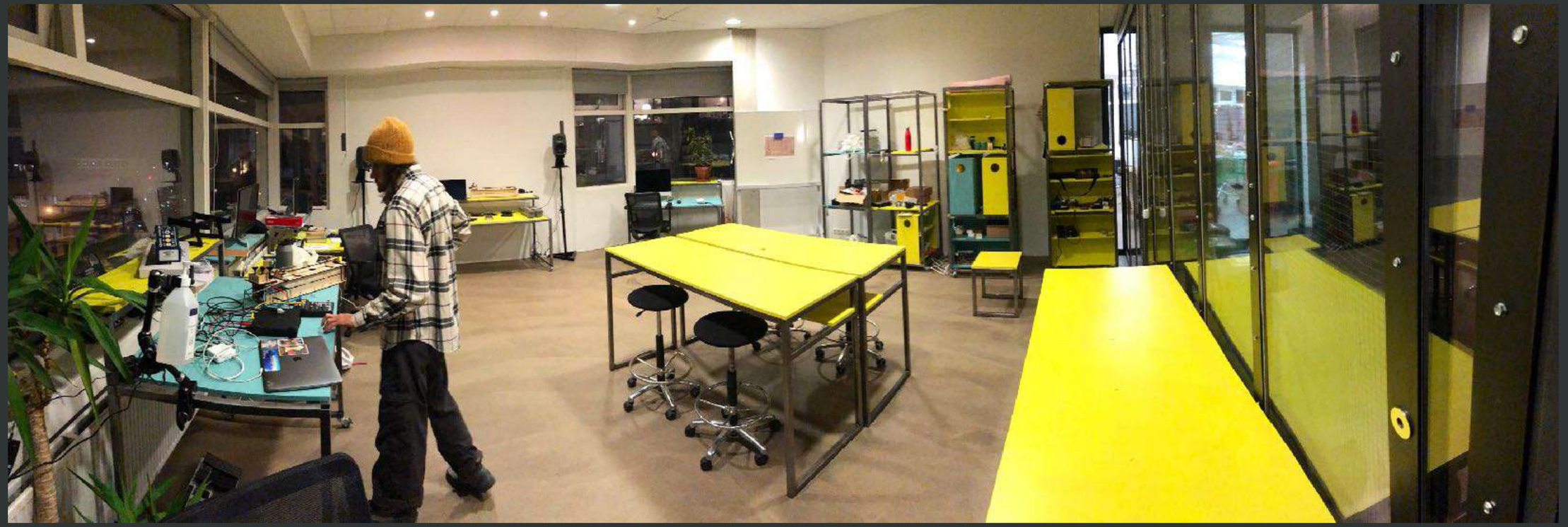
LISTAHÁSKÓLI ÍSLANDS
Iceland University of the Arts

1 September 2021

LISTAHÁSKÓLI ÍSLANDS
Iceland University of the Arts



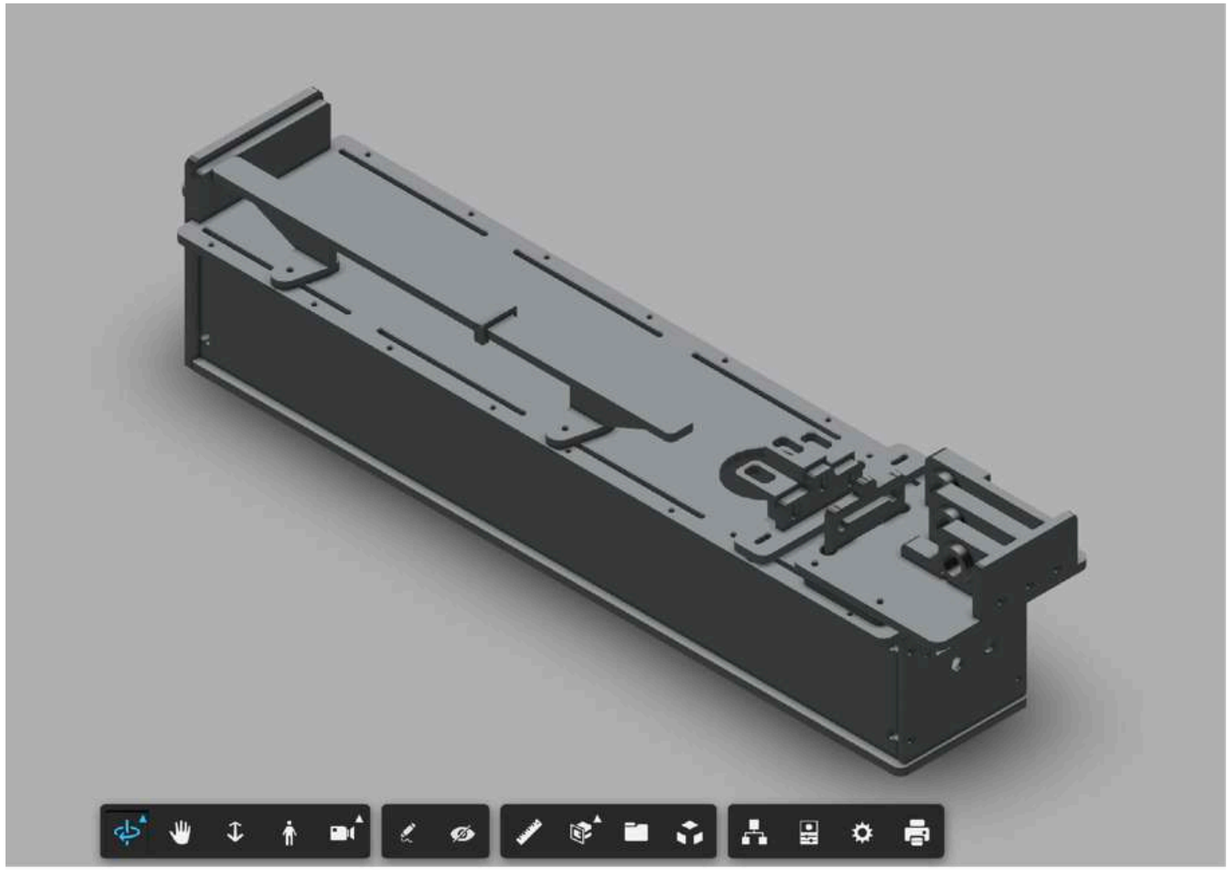
30 November 2021

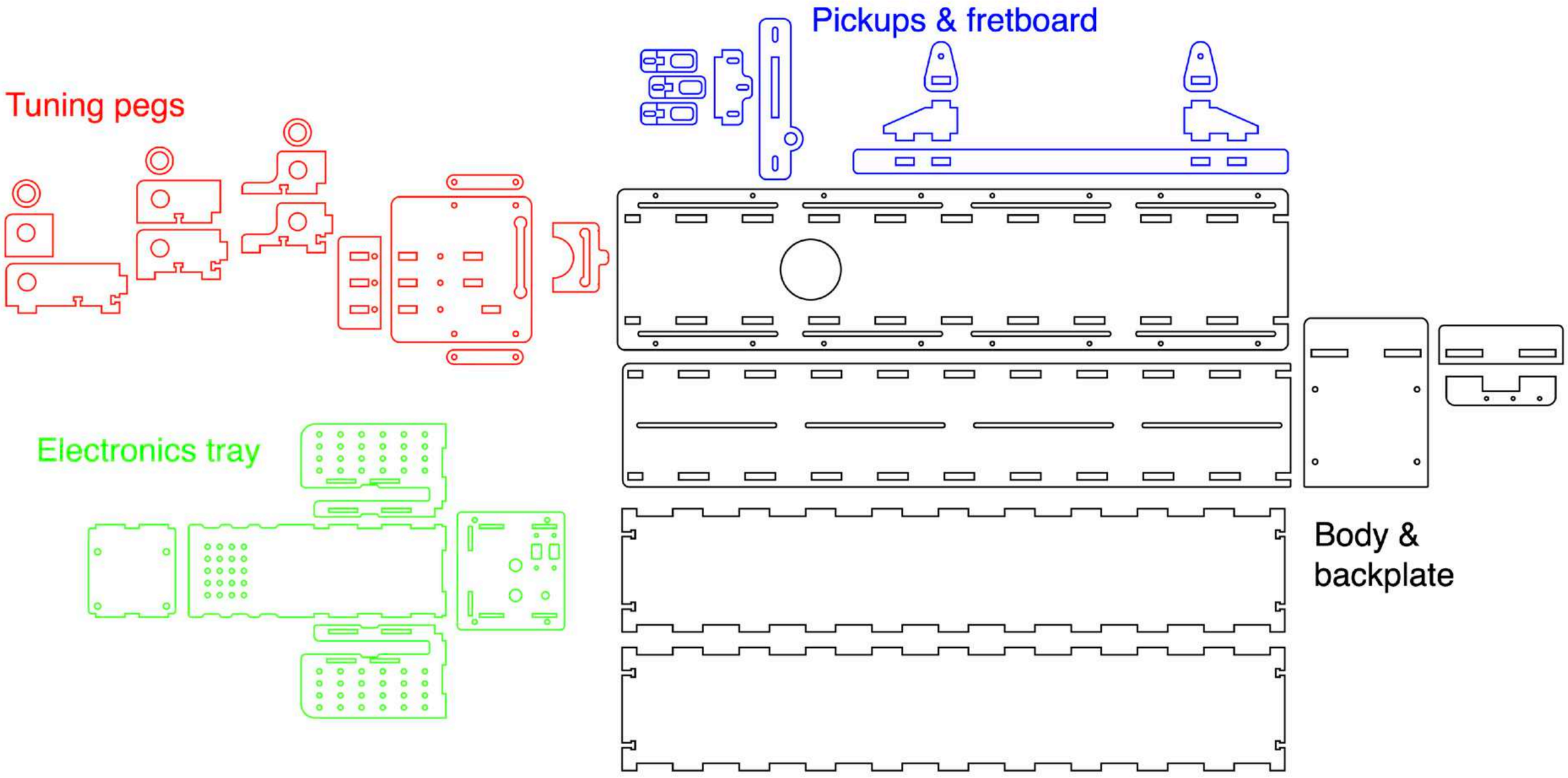
The Icelandic langspil

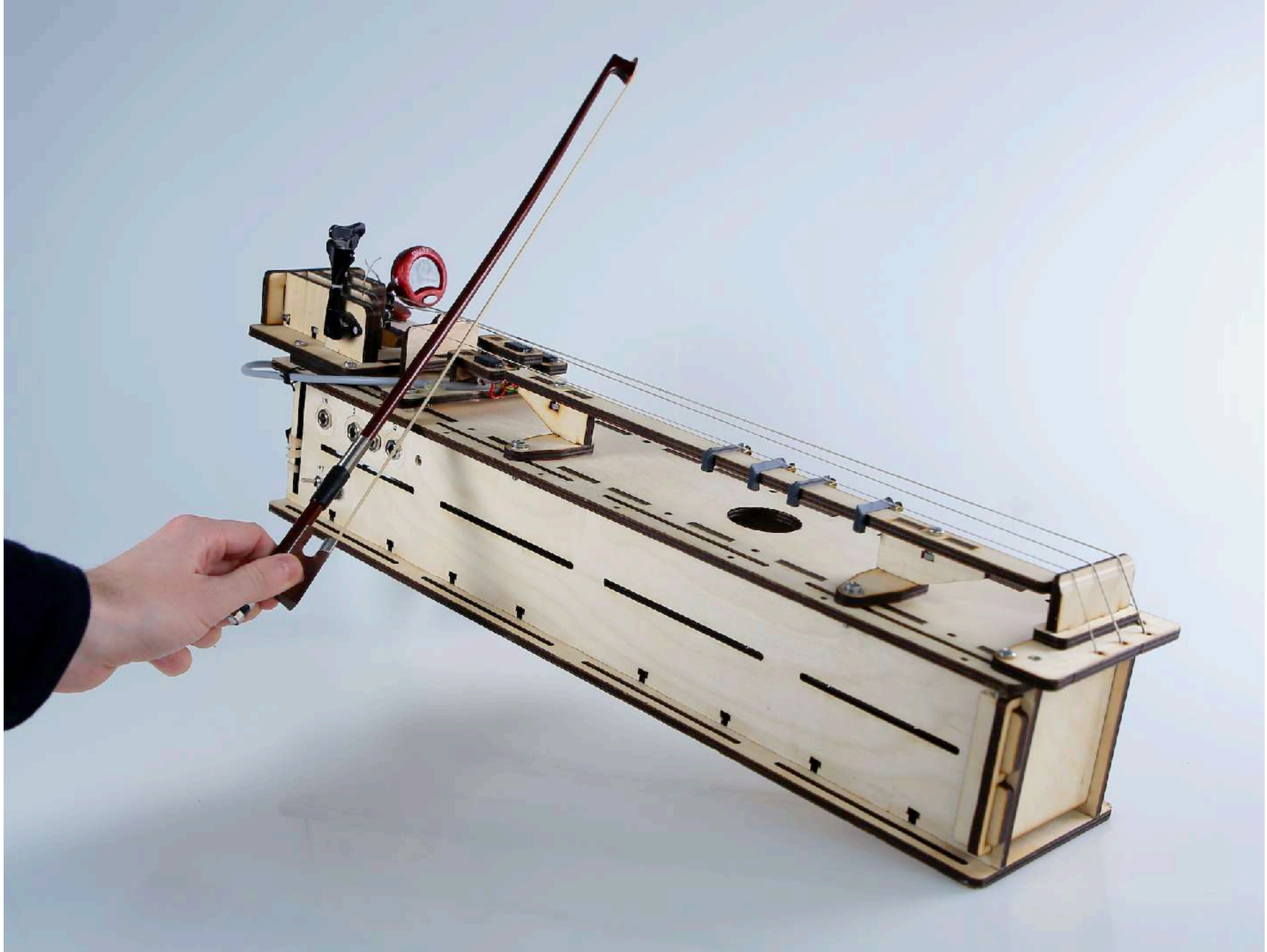
Icelandic version of the monochord is called langspil.

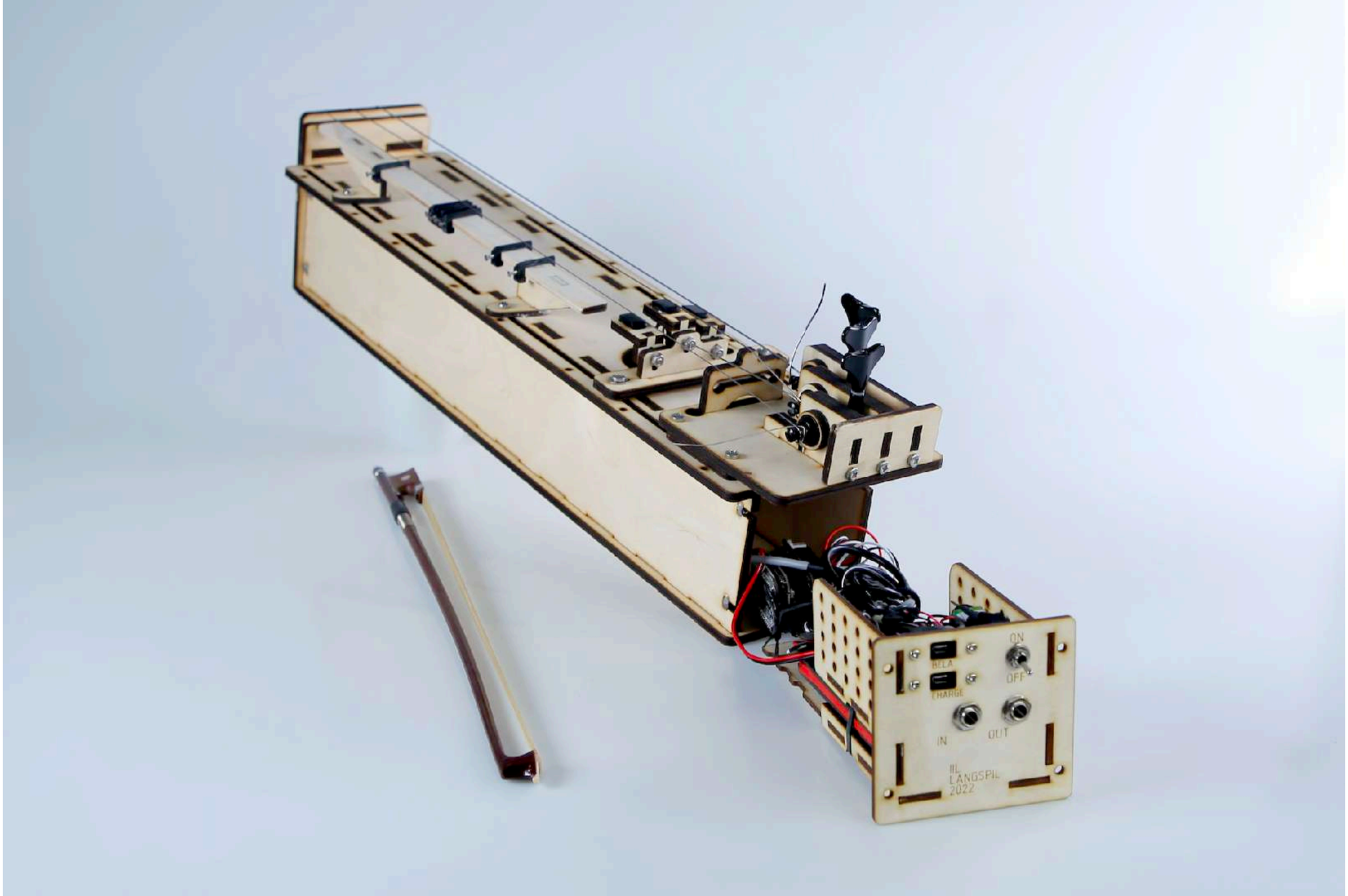
The instrument has one to six strings, where some are used as drone strings.

From cardboard to CAD...

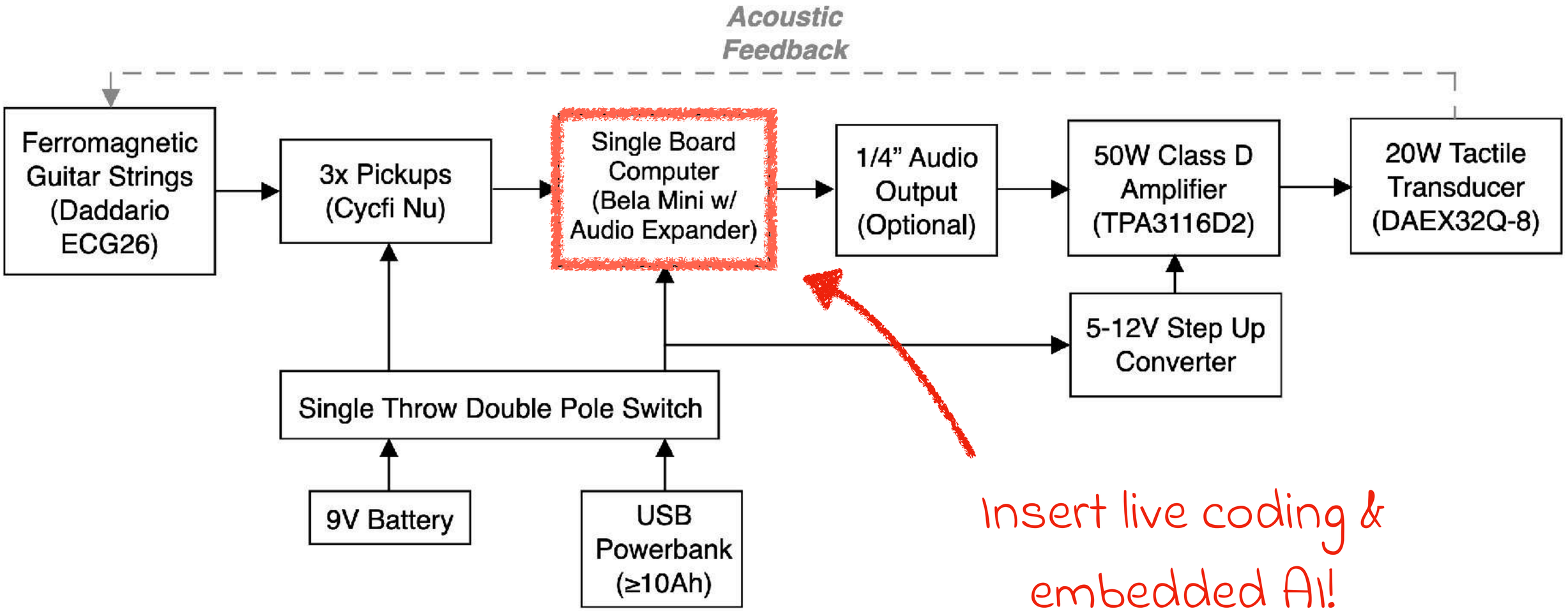


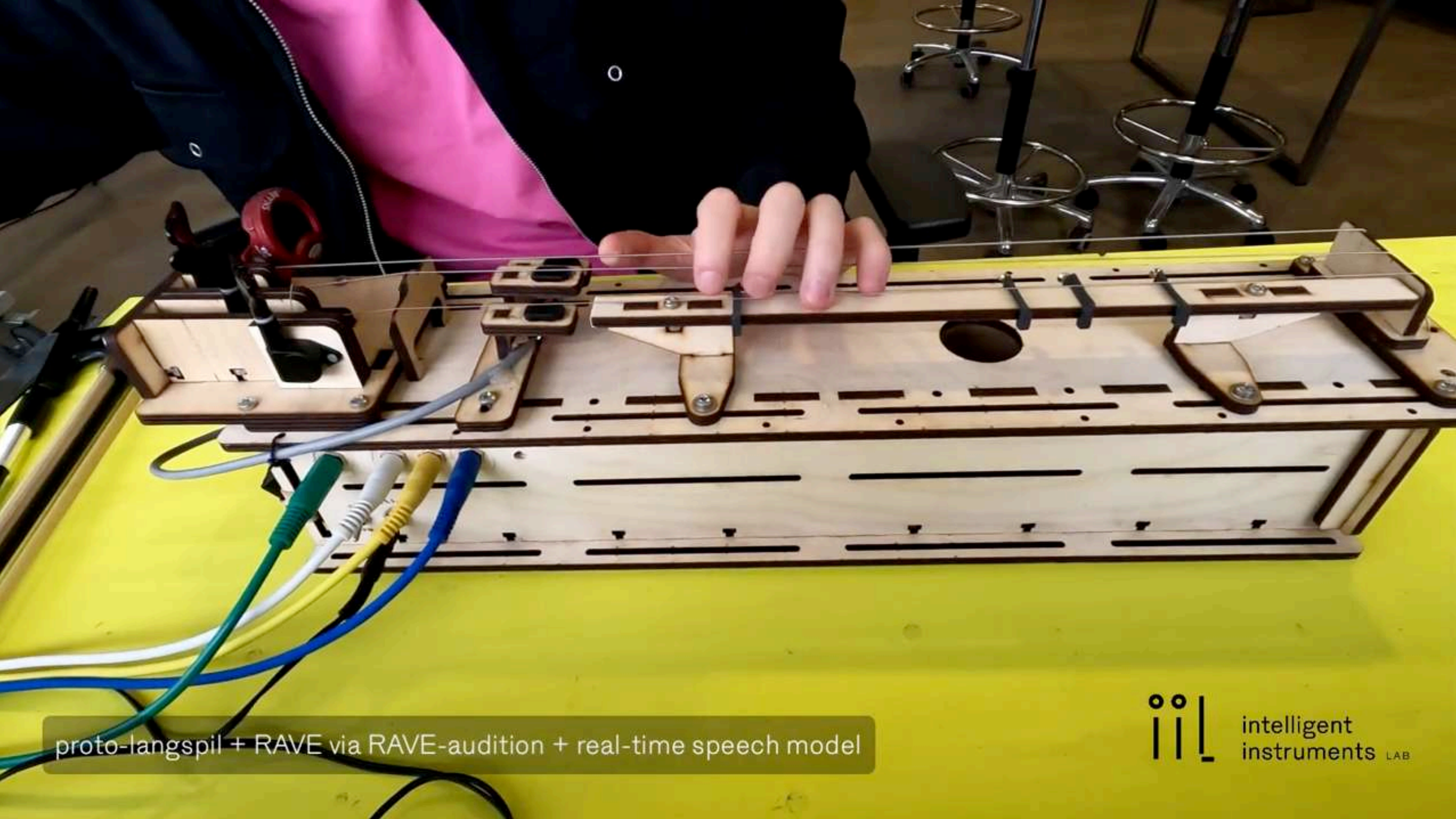

Tuning pegs
Pickups & fretboard
Electronics tray
Body &
backplate

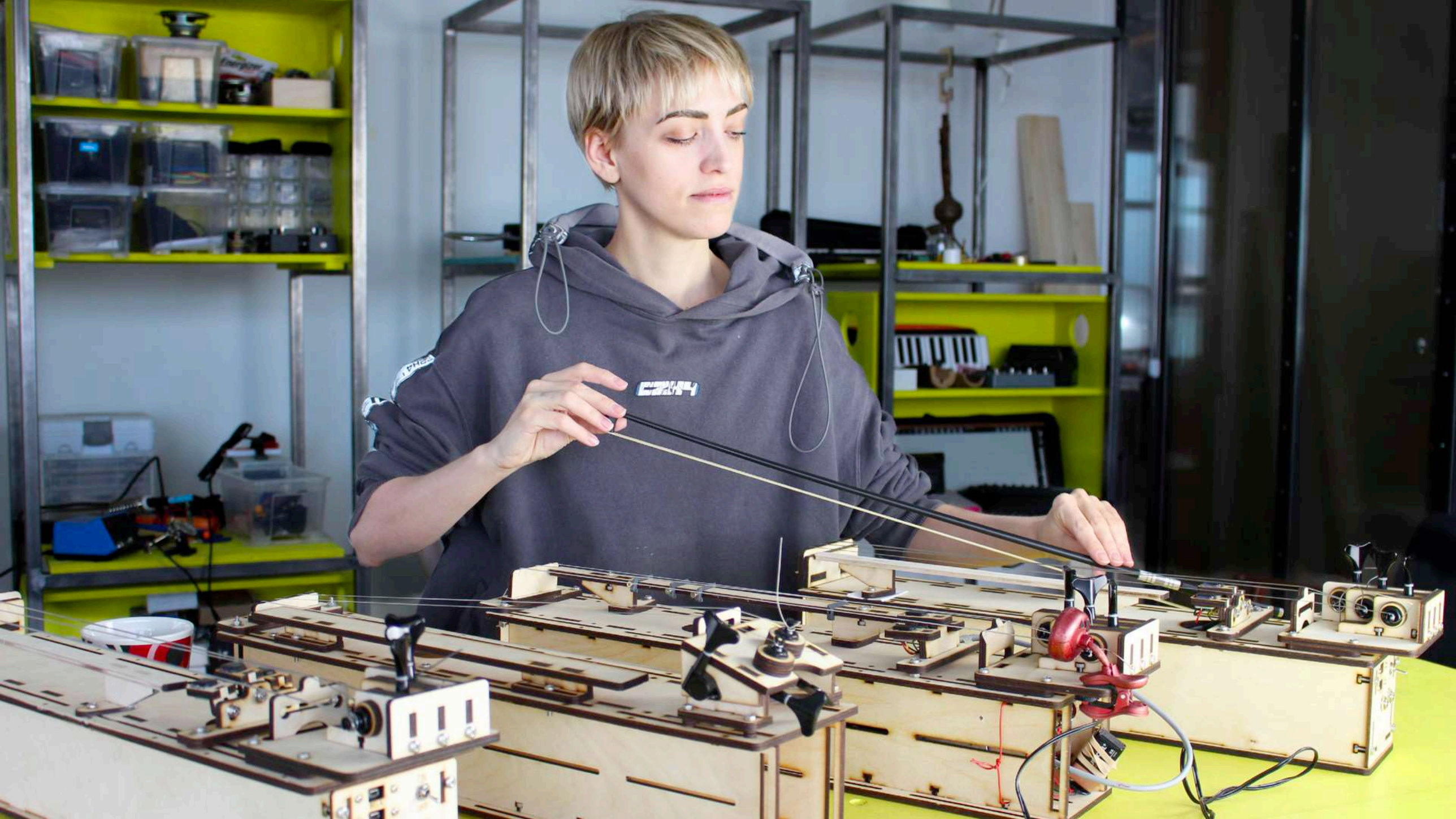



ON
OFF
BELA
CHARGE
IN
OUT
IL LANGSPIL
2022

Feedback as instrumental agency




proto-langspil + RAVE via RAVE-audition + real-time speech model
intelligent
instruments LAB



The artistic live coding community

The artistic live coding community

- TOPLAP
- Algorave
- Research venues
- Live coding systems

TOPLAP

Follow

TOPLAP
@toplaporg

The home of Live Coding
Blog - toplap.org
Discussion - forum.toplap.org
Chat rooms - discord.com/invite/D4Enr5u...
See also: @incolico @algorave

toplap.org Joined October 2011

605 Following **3,504** Followers

Transnational Organisation for the Proliferation of Live Artistic Programming

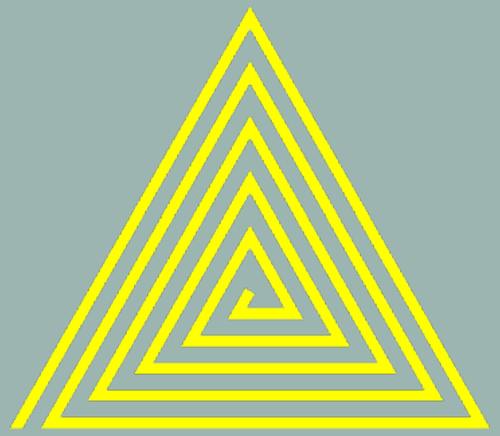
- An organisation founded in 2004 to explore and promote live coding.
- forum.toplap.com
- twitter.com/toplaporg
- github.com/toplap/awesome-livecoding: 55x languages; 59x libraries & tools
- International “nodes”:

Live Code London (UK)TOPLAP Karlsruhe (DE)TOPLAP ATH (GR)Algorave Makersmiths Purcellville (USA)
Comunidad de Live Coders – Perú (PE)LCCC (Live Coders Collective Copenhagen) (DK)Algorave|DK (DK)Livecode NYC (USA)
TOPLAP Node Yorkshire (UK)TOPLAP Node North-East (UK)TOPLAP Node México (MX)Cybernetic Orchestra (CA)TOPLAP Berlin (DE)
TOPLAP Medellín (CO)TOPLAP Bogotá (CO)TOPLAP Quito (EC)TOPLAP Lima (PE)Live coding à Montréal (CA)TOPLAP Barcelona (ES)
TOPLAP Japan (JP)NL_CL (Netherlands Coding Live) node (NL)Live coding @ IMPA (Rio de Janeiro) (BR)TOPLAP Greater Bay Area (CN)
Tidalclub Sheffield (UK)CLiC (Colectivo de Live Coders) (AR)Livecode New England (USA)TOPLAP Italia (IT)TOPLAP France (FR)
Algorave France & Belgique (FR/BE)Live Coding Frankfurt (DE)TOPLAP Valdiva (CL)LiveCoding Düsseldorf (DE)Toplap Shangai (CN)
Toplap Taiwan (CN)TOPLAP Israel (IL)TOPLAP Lyon (FR)Livecoding CR (CR)

TOPLAP 'draft manifesto' excerpts (2004)

- Give us access to the performer's mind, to the whole human instrument.
- Obscurantism is dangerous. Show us your screens.
- Programs are instruments that can change themselves.
- The program is to be transcended - Artificial language is the way.
- Code should be seen as well as heard, underlying algorithms viewed as well as their visual outcome.

Algorave




cps 1.5
d0 $ superimpose (iter 4) $ slow 2 $ midinote "{60 [55 35], 45 ~ [26 26] ~ ~}"
sound "ro"
midichan "0"
d5 silence
d1 $ density"<1 2 1>" $ loopAt "<8 4>" $ sound "wood wood" # cut 1
d2 $ sound "{~ [bb:5*2]/4, bb/3 bb:5/4}" # vowel "a"
d
hush

ALGORAVE (Algorithmic Rave)

Excerpt from the guidelines (see algorave.com)

- A community, not a protected brand or franchise
- Be wary of sponsorship or partnership with institutions
- Collapsing hierarchies - ‘headliner’ mentality not encouraged
- Respect for other communities - not the ‘future of dance music’
- Building local and online communities
- Diversity in lineups and audiences - create space for ‘beginners’

Algorave in the media

mixmag

HOME LATEST NEWS MENU

FEATURES

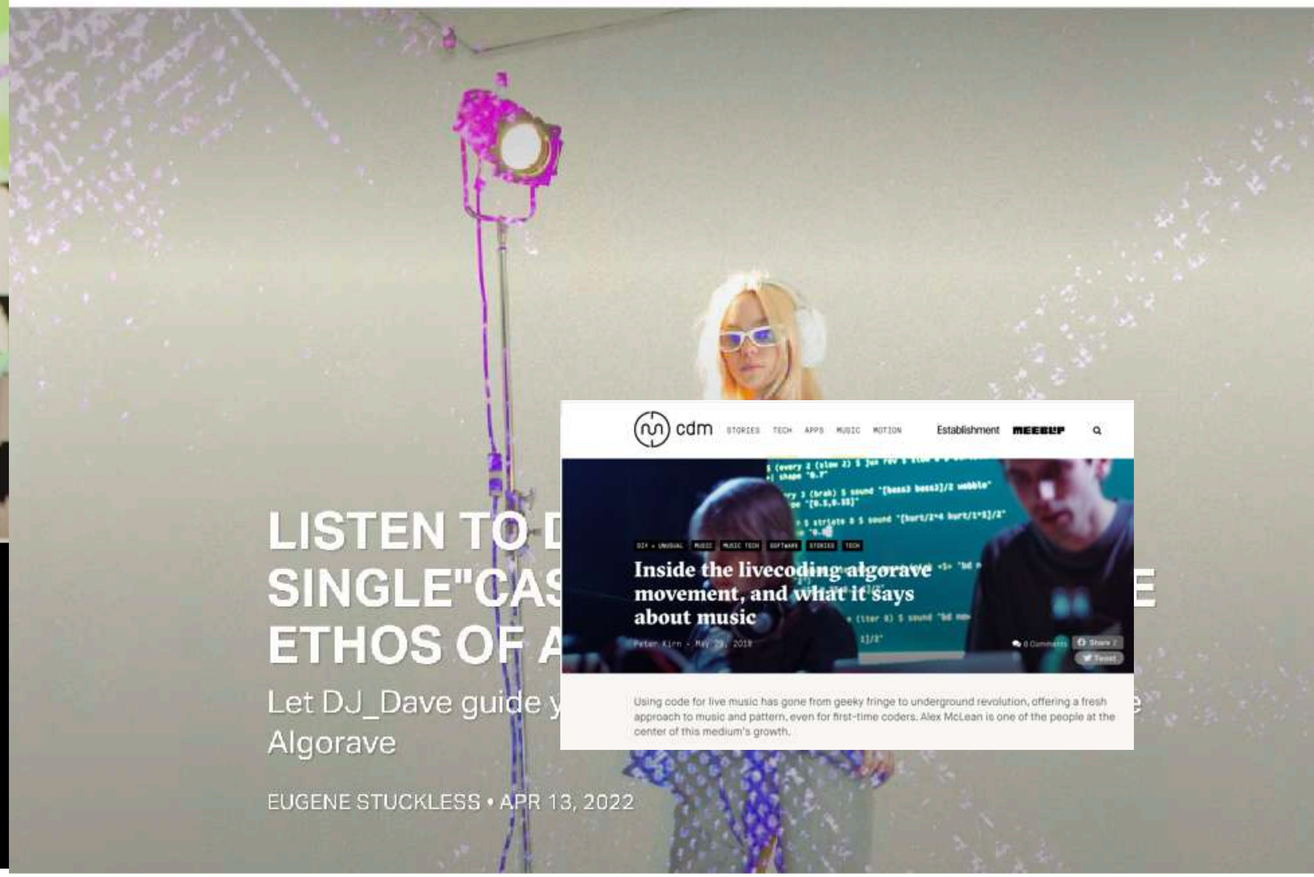
SO DIFFERENT, GENUINELY FUN: EXPLORING 10 YEARS OF ALGORAVE

10 years deep, the live coding movement has grown from an outsider practice to an established mode of music making. Niamh Ingram explores algorave's evolution and how it might move into the future

MONTHLY TOP 15 CHARTS
CLICK HERE

MAGNETIC MAGAZINE

SUSTAINABILITY GAMING NEWS MUSIC CULTURE GEAR EVENTS INDUSTRY



LISTEN TO D
SINGLE"CAS E
ETHOS OF A

Let DJ_Dave guide y
Algorave

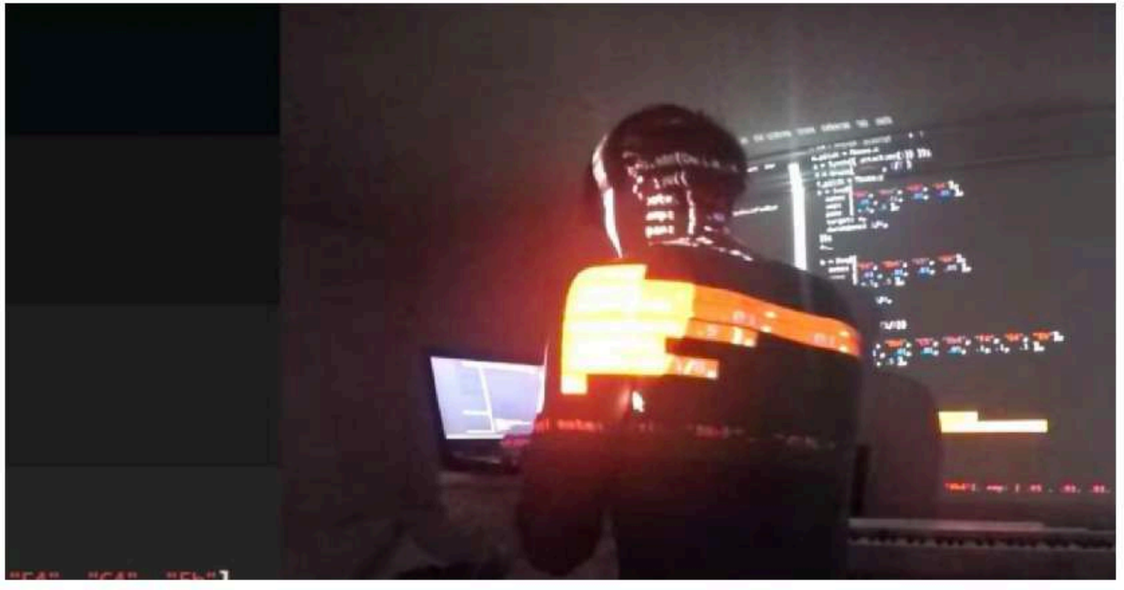
EUGENE STUCKLESS • APR 13, 2022

electronic beats

Read Listen

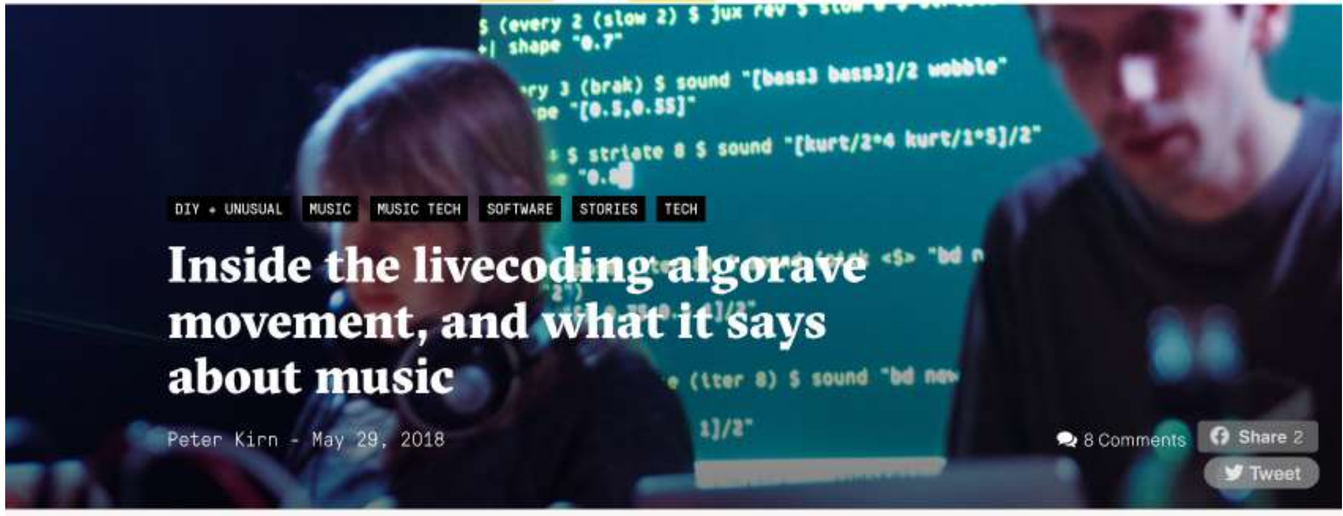
TECH

Code-Generated Algorave Is The Next Big Thing in Dance Music



Artists who use live coding platforms are crafting new ways to DJ and produce music.

cdm STORIES TECH APPS MUSIC MOTION Establishment MEEBLIP



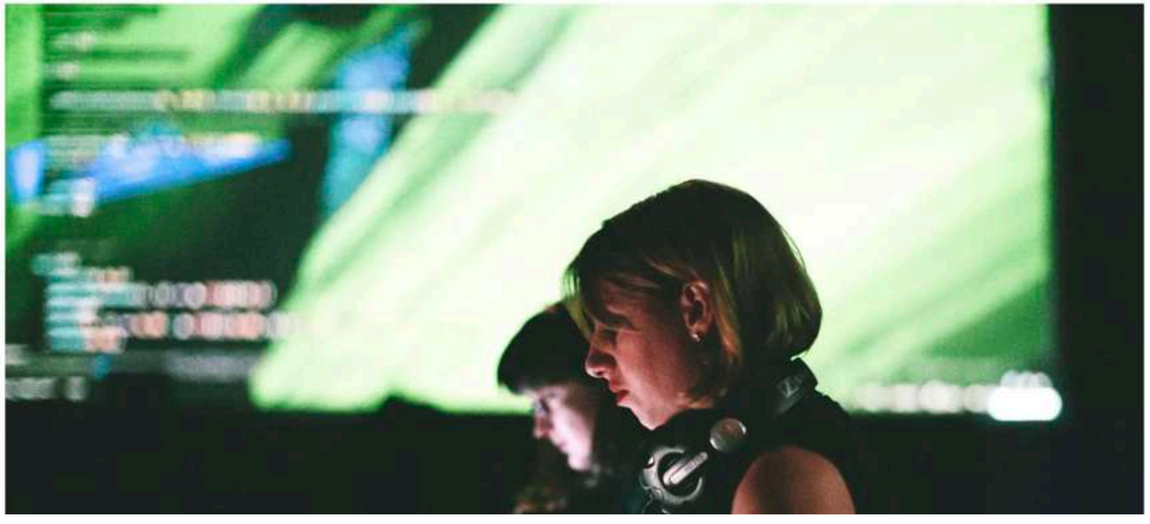
Using code for live music has gone from geeky fringe to underground revolution, offering a fresh approach to music and pattern, even for first-time coders. Alex McLean is one of the people at the center of this medium's growth.

WIRED BACKCHANNEL BUSINESS CULTURE GEAR IDEAS SCIENCE MORE SIGN IN SUBSCRIBE

MICHAEL CALORE CULTURE MAR 26, 2019 9:00 AM

DJs of the Future Don't Spin Records—They Write Code

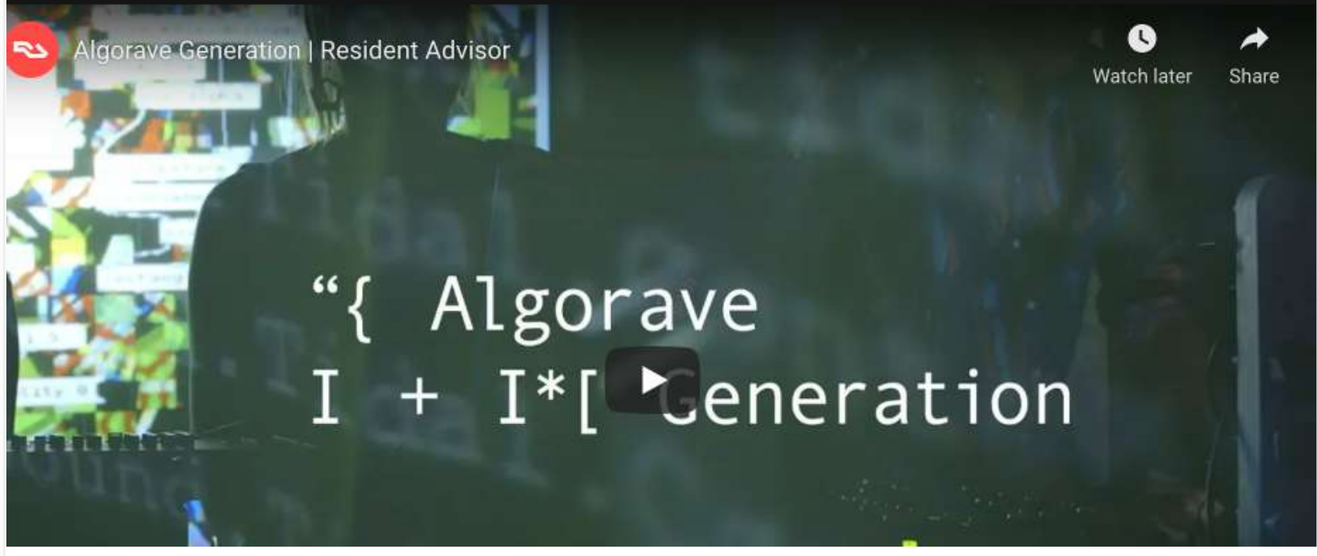
"Live-coding" parties are the latest phenomenon in underground electronic music culture.



Events Music Magazine My account RA Pro

Features

Algorave Generation



ARTS

Algorave — the nerdiest clubbing trend of them all

It's the dance sensation where brainy DJs with PhDs play unpredictable music made from live coding and algorithms to ravers

Will Hodgkinson

Thursday May 09 2019, 12.01am, The Times

Last night a DJ saved my life (and did my maths homework): algoraves
ANTONIO ROBERTS

Music + Add to myFT

Electronic dance music and 'algorave' – how live coding got cool

Music, visuals and computer code are being blended to create an entrancing experience

Save

Events such as this one curated by Algorave have brought live coding in from the fringes

Diversity in Algorave

Spaces to Fail in:
Negotiating Gender, Community and Technology in Algorave

Feature Article

Joanne Armitage
University of Leeds (UK)

Abstract

Algorave presents itself as a community that is open and accessible to all, yet historically, there has been a lack of diversity on both the stage and dance floor. Through women-only workshops, mentoring and other efforts at widening participation, the number of women performing at algorave events has increased. Grounded in existing research in feminist technology studies, computing education and gender and electronic music, this article unpacks how techno, social and cultural structures have gendered algorave. These ideas will be elucidated through a series of interviews with women participating in the algorave community, to centrally argue that gender significantly impacts an individual's ability to engage and interact within the algorave community. I will also consider how live coding, as an embodied techno-social form, is represented at events and hypothesise as to how it could grow further as an inclusive and feminist practice.

Keywords: gender; algorave; embodiment; performance; electronic music

feminist review

don't touch my MIDI cables: gender, technology and sound in live coding

Feminist Review
Issue 127, 90–106

DOI: 10.1177/0141778920973221
www.feministreview.com
SAGE

Joanne Armitage and Helen Thornham

abstract

Live coding is an embodied, sensorial and live technological–human relationship that is recursively iterated through sonic and visual outputs based on what we argue are kinship relations between and through bodies and technology. At the same time, and in a familiar moment of déjà vu for feminist scholars, live coding is most often discussed not in relation to the lived and sensory human–technology kinship, but in terms of fetishised code or software, output and agency. As feminist scholars have long argued, emphasising and fetishising code or software, and celebrating output and agency are normatively masculine, white and Western conceptions of technology that feed into the growing valorisation of accelerationist logic whilst also negating embodied, not to mention other (non-white, Western, masculine) bodies, expertise or histories *per se*. In this article, we want to redress this by drawing on our empirical material on live coding to focus on human–technology kinship and, in so doing, think about failure, slowness and embodiment and about human–technology relations that are more akin to what Alison Kafer (drawing on the work of Donna Haraway) has termed 'becoming with' or 'making kin'. This, we argue, has the potential to shift the focus from the potentialities of technologies on or through the body, towards the generative capacities of mediation (including failure), which are caught up in lived experiences. The question is not only about how the relations of bodies and technologies are played out in certain circumstances but about what might be played out if we reconceptualise these relations in these terms.

keywords

live coding; gender; sound; technology; code; cyberfeminisms

(Algo|Afro) Futures is a mentoring programme for early career Black artists who want to explore the creative potential of live coding.

Live coding is a performative practice where artists and musicians use code to create live music and live visuals. This is often done at electronic dance music events called Algoraves, but live coding is a technique rather than a genre, and has also been applied to noise music, choreography, live cinema, and many other time-based artforms.

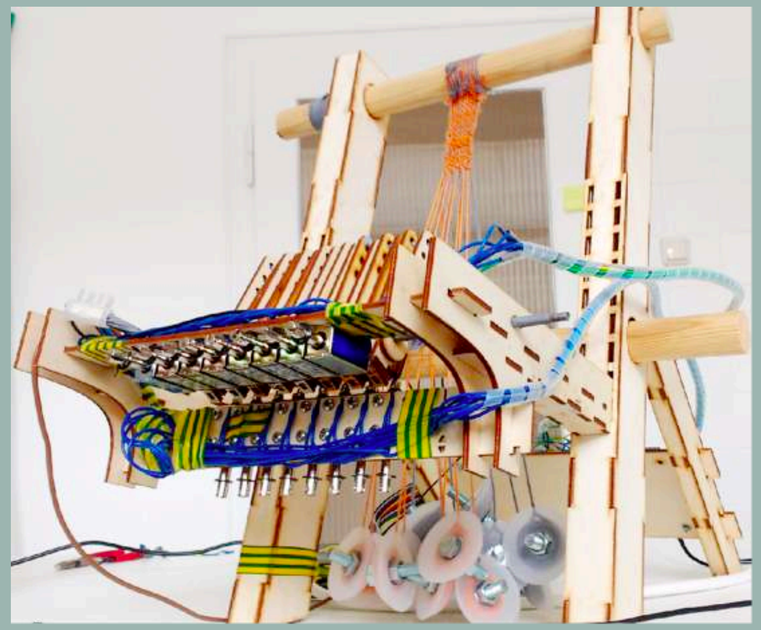
Research

International Conference on Live Coding ("incolico") (ICLC)

- Valdivia, Chile, 2021
- Limerick, Ireland, 2020
- Madrid, Spain, 2019
- Morelia, México, 2017
- McMaster University, Canada, 2016
- University of Leeds, UK, 201

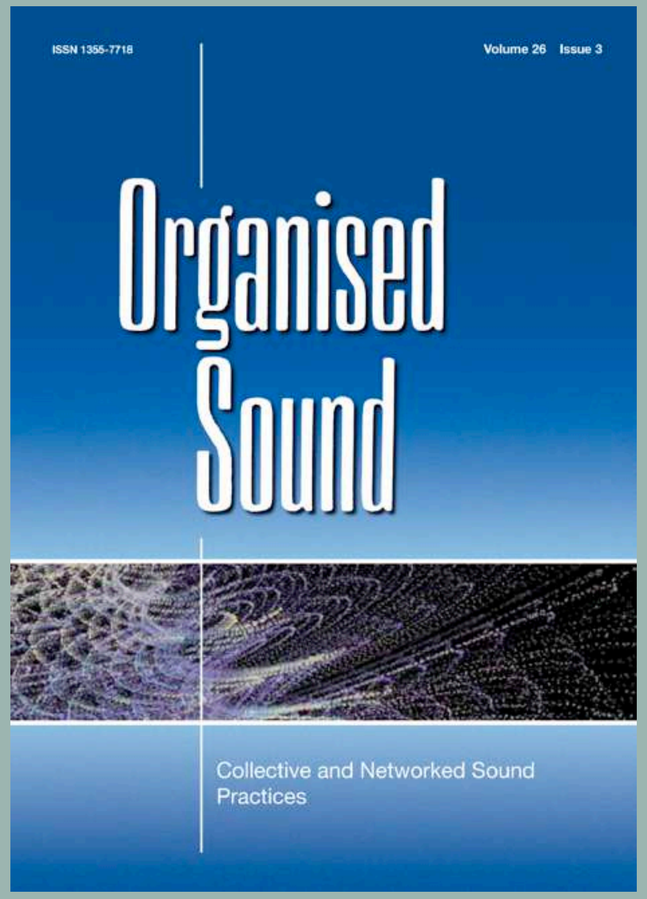
Hybrid Live Coding Interfaces workshop (HLCI)

- Online in 2021 & 2022
- Archived at hybrid-livecode.pubpub.org



Organised Sound - Special Issue Call for Articles

Live Coding Sonic Creativities

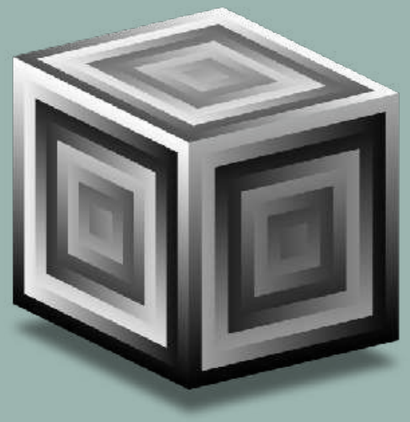


CAMBRIDGE

- Submit by September 15th 2022

Live coding systems

Live coding systems for music

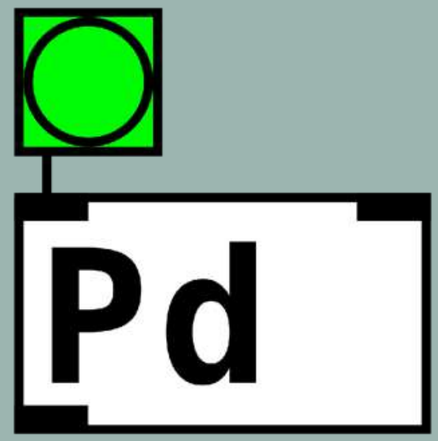


SuperCollider (1996-)

- Inspired by Smalltalk
- Object-oriented / message passing

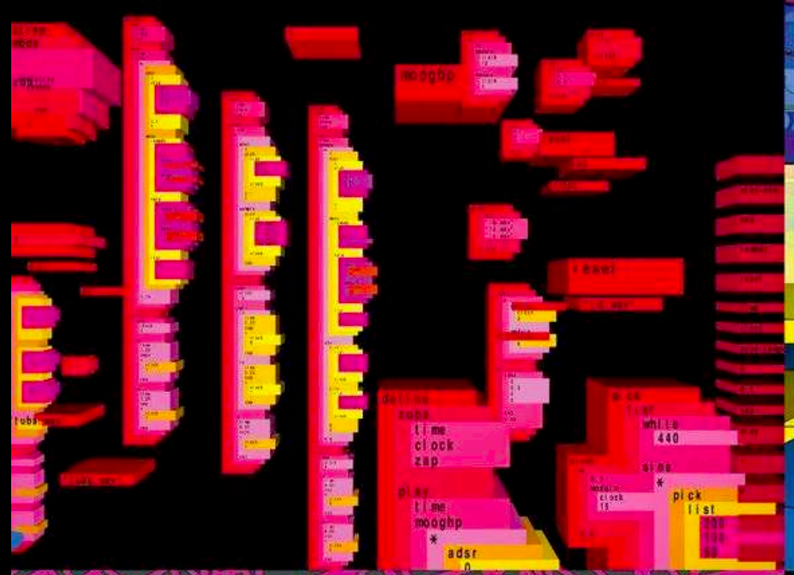
TidalCycles (2010-)

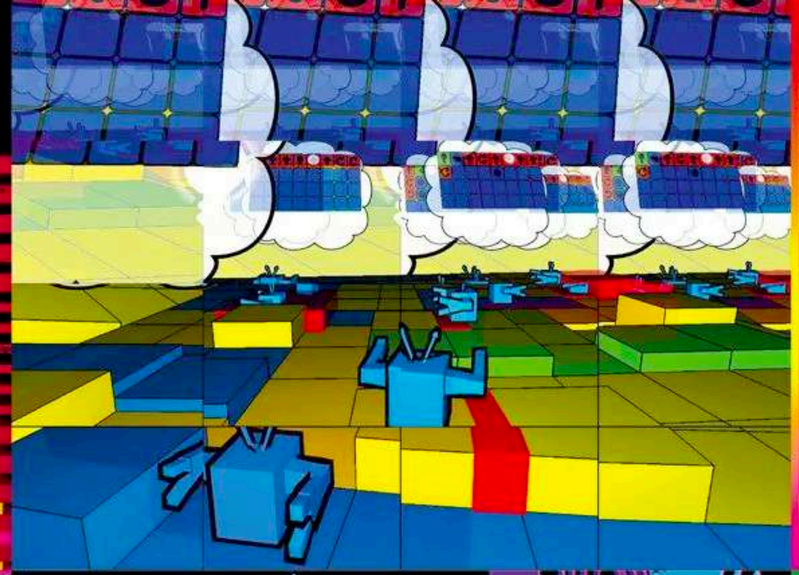
- Haskell library
- String-based notation of pattern



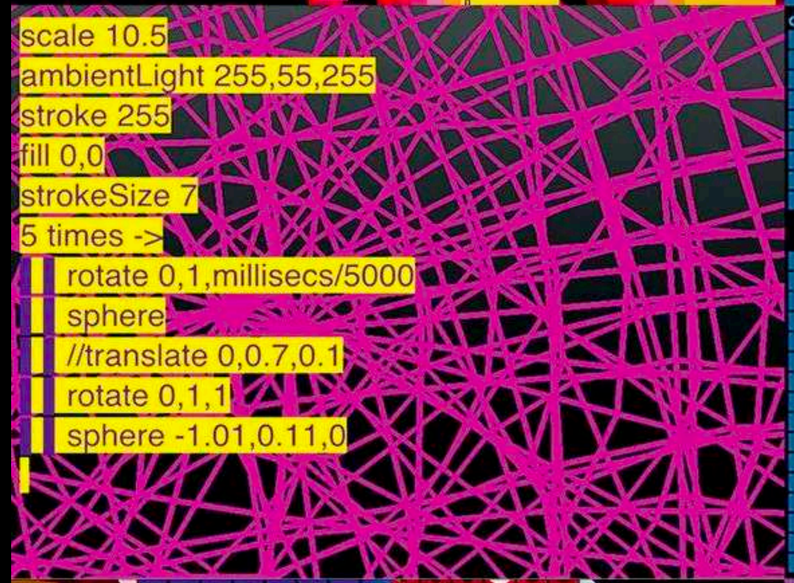
Pure Data (1996-)

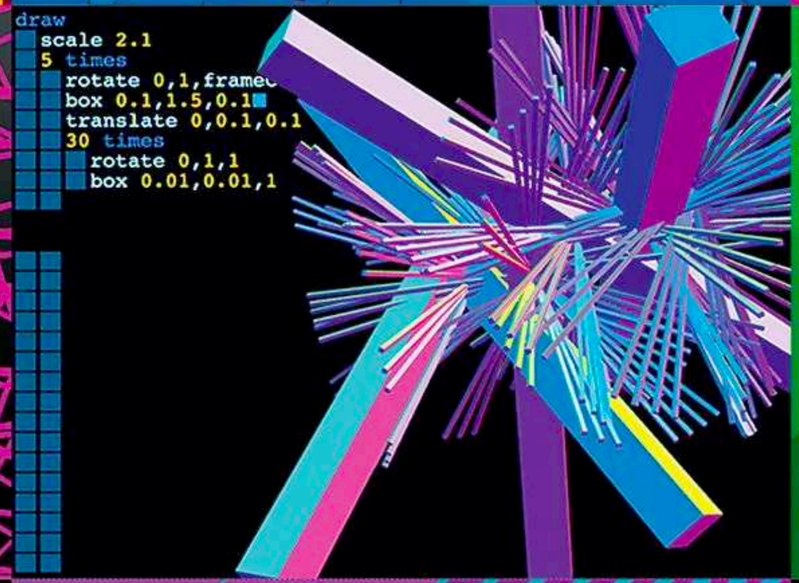
- Dataflow programming
- Open source cousin of Max/MSP



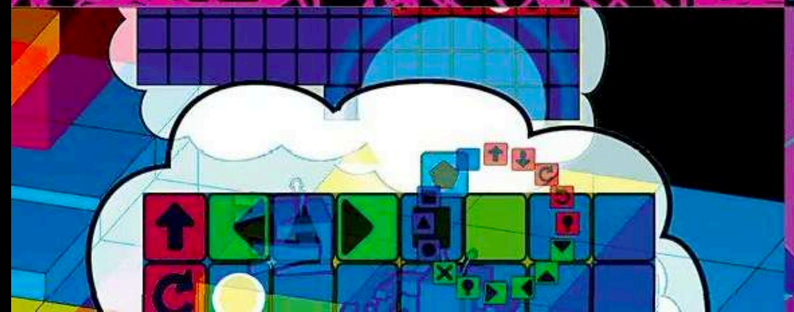



scale 2
rotate millisecs/4000, millisecs/4000, millisecs/4000
90 times ->
line
line
move -0.5,0,0
line
line

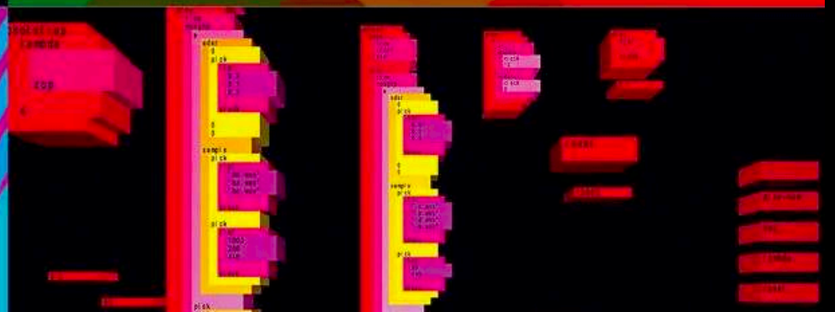

scale 10.5
ambientLight 255,55,255
stroke 255
fill 0,0
strokeSize 7
5 times ->
rotate 0,1,millisecs/5000
sphere
//translate 0,0.7,0.1
rotate 0,1,1
sphere -1.01,0.11,0


draw
scale 2.1
5 times
box 0.1,1.5,0.1
translate 0,0.1,0.1
30 times
rotate 0,1,1
box 0.01,0.01,1


scale 10.5
2 times ->
rotate 0,1,millisecs/10000
sphere
sphere -1




scale 4
background 155,55,255
70 times ->
box



Artistic uses of Cling

tinyspec-cling

Tiny spectral synthesizer with live coding support.

tinyspec-cling

tiny spectral synthesizer with live coding support

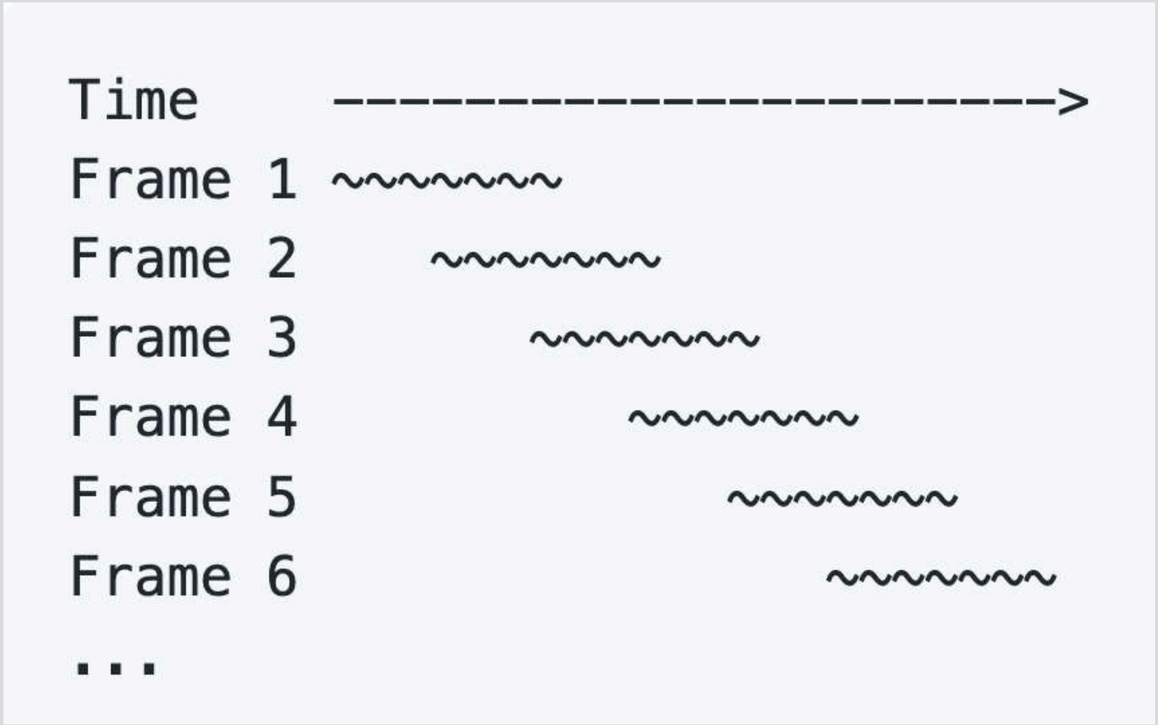
- A tiny C++ live-coded overlap-add (re)synthesizer for Linux, which uses cling to add REPL-like functionality for C++ code.
- Create novel audio effects using FFT, phase vocoders and more, and control them with Open Sound Control (OSC)
- Create synthesizers, granular synthesis, bytebeats (time and frequency domain)
- Control other software with OSC
- Use these synthesizers and effects with DAWs, other synthesizers, etc using JACK
- o all of this in a live performance (with some caveats)

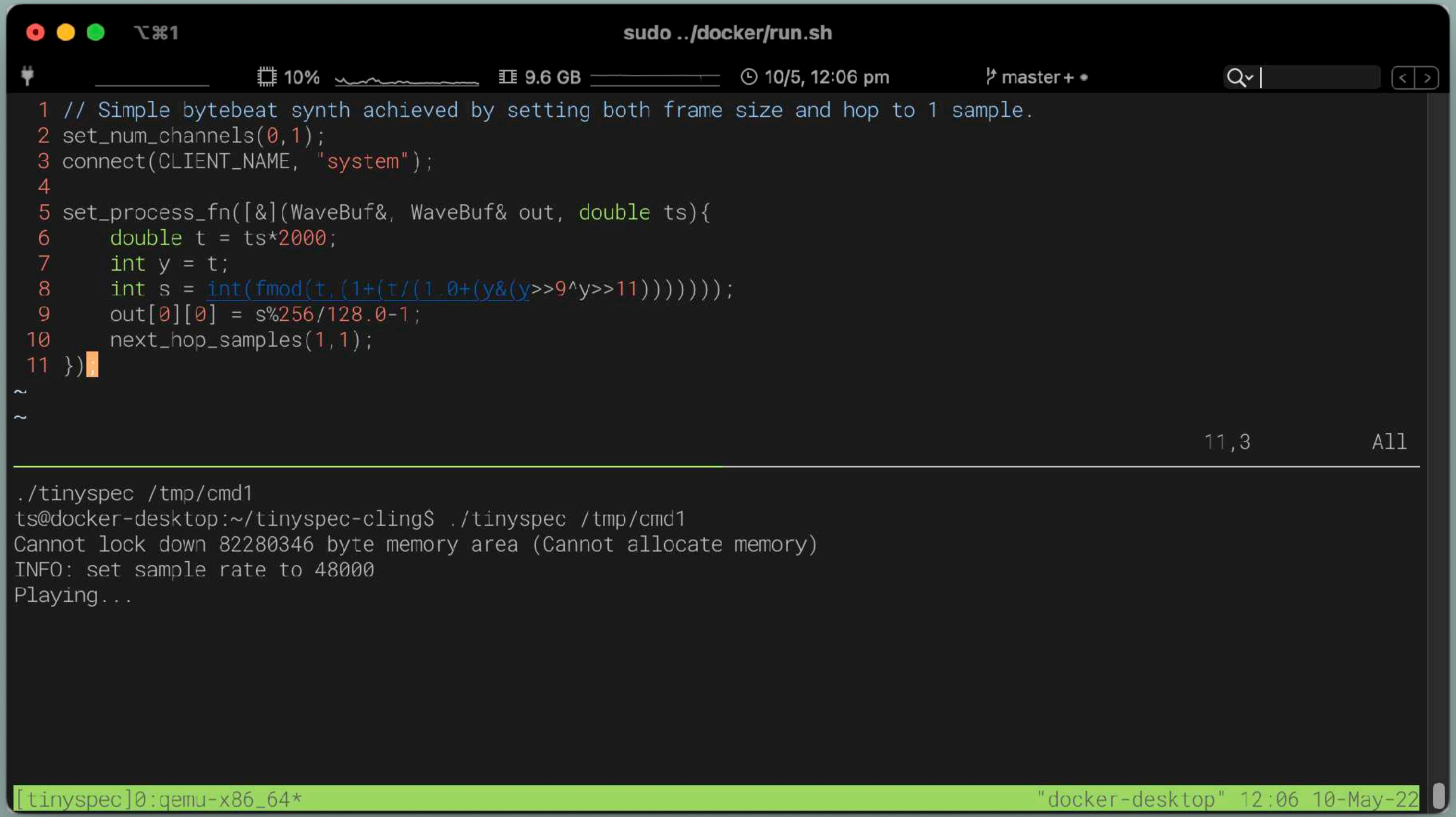
Created by Noah Weninger

byte.observer

Overlap-add (re)synthesis

- A function is called periodically to process a frame of audio.
- E.g., phase vocoding is often performed with a 4:1 frame size to hop size ratio
- In this example, the “hop” is 3 samples, and the frame size is 7:




⌥⌘1
sudo ../docker/run.sh
10%
9.6 GB
10/5, 12:06 pm
master +
1 // Simple bytebeat synth achieved by setting both frame size and hop to 1 sample.
2 set_num_channels(0,1);
3 connect(CLIENT_NAME, "system");
4
5 set_process_fn([&](WaveBuf&, WaveBuf& out, double ts){
6 double t = ts*2000;
7 int y = t;
8 int s = int(fmod(t,(1+(t/(1.0+(y&(y>>9^y>>11)))))));
9 out[0][0] = s%256/128.0-1;
10 next_hop_samples(1,1);
11 });
~
~
11,3 All
./tinyspec /tmp/cmd1
ts@docker-desktop:~/tinyspec-cling$ ./tinyspec /tmp/cmd1
Cannot lock down 82280346 byte memory area (Cannot allocate memory)
INFO: set sample rate to 48000
Playing...
[tinyspec]0:qemu-x86_64* "docker-desktop" 12:06 10-May-22

“bytebeat”: somewhat melodic music with no score, no instruments, and no real oscillators

```
5  set_process_fn([&](WaveBuf&, WaveBuf& out, double ts){
6      double t = ts*2000;
7      int y = t;
8      int s = int(fmod(t,(1+(t/(1.0+(y&(y>>9^y>>11))))))));
9      out[0][0] = s%256/128.0-1;
10     next_hop_samples(1,1);
11 });
```

music community

boat style

by byte.observer

00:00 / 22:08

Digital Track

Streaming + Download

Free Download

100% produced with github.com/nwoeanhinnogaehr/tinyspec-cling and github.com/musikinformatik/SuperDirt

released July 13, 2019

Share / Embed

tinyspec-cling

github.com/nwoeanhinnogaehr/tinyspec-cling

byte.observer

2. Cling in embedded instruments

Using the Bela interactive audio platform.

International Conference on New Interfaces for Musical Expression (nime.org)

- “NIME gathers researchers and musicians from all over the world to share their knowledge and late-breaking work on new musical interface design.”
- Started as a workshop at the Conference on Human Factors in Computing Systems (CHI) in 2001.
- Annual series of conferences held around the world, hosted by research groups dedicated to interface design, human-computer interaction, and computer music.

Google Scholar

Top publications

Categories > Humanities, Literature & Arts > **Music & Musicology**

	Publication	h5-index	h5-median
1.	International Society for Music Information Retrieval Conference	37	60
2.	Psychology of Music	34	49
3.	Music Education Research	22	31
4.	Journal of Research in Music Education	21	34
5.	Musicae Scientiae	21	30
6.	Music Perception: An Interdisciplinary Journal	21	28
7.	International Journal of Music Education	20	28
8.	Journal of New Music Research	19	29
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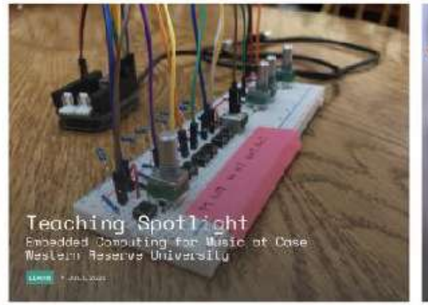
bela.io

The Bela Blog

Beautiful, inspiring projects from Belas worldwide community of ambitious creators.



Embedded platforms for instrument makers

Raspberry Pi

- Embedded Linux with user space
- Low quality audio hardware
- High latency and jitter due to OS

Arduino

- Microcontroller - good for IO!
- No OS = no latency/jitter
- Insufficient CPU, harder to program

Bela: open source platform for interactive audio projects

- Hardware cape for BeagleBoard Black & Mini
  - PRUs enable microcontroller-level IO control & performance
- Software OS based on Xenomai “hard real-time” Linux
  - Custom real-time process with higher priority than entire OS
  - 1ms roundtrip audio latency (~10ms considered “good”)
- User friendly IDE, large examples library, online knowledge base & teaching courses
- Polyglot: C++, SuperCollider, Pure Data, Faust, Csound, Rust, Python...
- BUT! Slow(er) compile times & no live coding is frustrating for makers who need real-time feedback and iteration!

Augmented Instruments Laboratory

instrumentslab.org

Bela C++ API

Project: sinetone (example) File: render.cpp

```cpp
#include <Bela.h>
#include <cmath>

float gFrequency = 440.0;
float gPhase;
float gInverseSampleRate;

bool setup(BelaContext *context, void *userData) {
    gInverseSampleRate = 1.0 / context->audioSampleRate;
    gPhase = 0.0;
    return true;
}

void render(BelaContext *context, void *userData) {
    for(unsigned int n = 0; n < context->audioFrames; n++) {
        float out = 0.8f * sinf(gPhase);
        gPhase += 2.0f * (float)M_PI * gFrequency * gInverseSampleRate;
        if(gPhase > M_PI) gPhase -= 2.0f * (float)M_PI;
        for(unsigned int channel = 0; channel < context->audioOutChannels; channel++)
            audioWrite(context, n, channel, out);
    }
}

void cleanup(BelaContext *context, void *userData){}
```

Programming Bela with Cling?

- Cross-compile Cling for BeagleBoard ARMv7 with hard-float architecture.
- Expose `render()` function globally (`gBelaRender`) so Cling can update it.

```
.I /root/Bela/include
.L /root/Bela/lib/libbela.so
.L /root/Bela/lib/libbelaextra.so
.x /root/Bela/projects/[project_folder]/[project_main].cpp

gBelaRender = cling_render // some new render function!
```

REPL access to `BelaContext` and Bela APIs!

```
[cling]$ bela->audioSampleRate
(const float) 44100.0f
[cling]$ analogRead(bela, 0, 0)
(float) 0.000259399f
```

Future work

- Updating to latest Cling
- Bela IDE integration
  - Integrated Cling REPL feedback into IDE terminal
  - Toolbar for loading files into the REPL, easy access to undo, etc
- Develop strategies for live coding musical instruments
  - More flexible C++ API suited to live coding
  - Preventing / catching errors
- Optimising Cling for hard real-time performance...?
  - ez-clang...?

Reflections

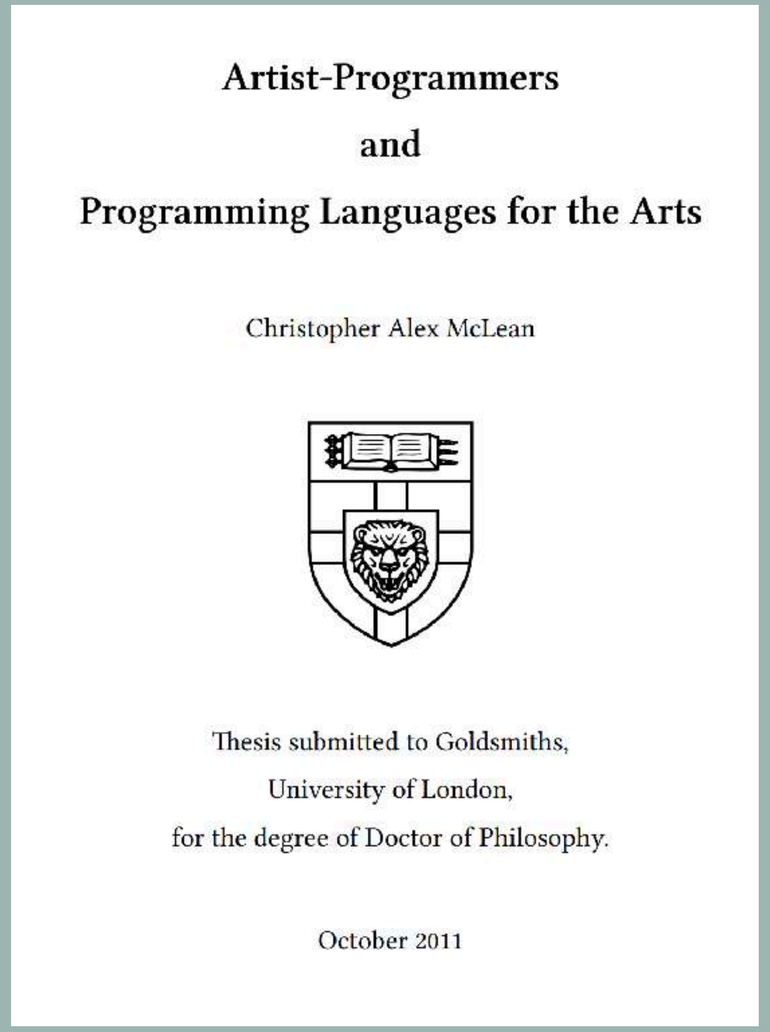
On scientific & artistic programming.

Artist-Programmers and Programming Languages for the Arts

Alex McLean, 2011, Thesis, Goldsmiths, University of London.

- “We consider the artist-programmer, who creates work through its description as source code. The artist-programmer grandstands computer language, giving unique vantage over human-computer interaction in a creative context.”

- “We form a cross-disciplinary perspective from psychology, computer science, linguistics, human-computer interaction, computational creativity, music technology and the arts.”



Artist-Programmers

and

Programming Languages for the Arts

Christopher Alex McLean

Thesis submitted to Goldsmiths,
University of London,
for the degree of Doctor of Philosophy.

October 2011

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Live coding

From Wikipedia, the free encyclopedia

Not to be confused with Interactive programming.

Live coding,[1] sometimes referred to as **on-the-fly programming**,[2] **just in time programming** and **conversational programming**, makes programming an integral part of the running program.[3]

It is most prominent as a performing arts form and a creativity technique centred upon the writing of source code and the use of interactive programming in an improvised way. Live coding is often used to create sound and image based digital media, as well as light systems, improvised dance and poetry,[4][5] though is particularly prevalent in computer music usually as improvisation, although it could be combined with algorithmic composition.[6] Typically, the process of writing source code is made visible by projecting the computer screen in the audience space, with ways of visualising the code an area of active research.[7] Live coding techniques are also employed outside of performance, such as in producing sound for film[8] or audiovisual work for interactive art installations.[9] Also, the interconnection between computers makes possible to realize this practice networked in group.

The figure of **live coder** is who performs the act of live coding, usually "artists who want to learn to code, and coders who want to express themselves"[10] or in terms of Wang & Cook the "programmer/performer/composer".[2]

Live coding is also an increasingly popular technique in programming-related lectures and conference presentations, and has been descri computer science lectures by Mark Guzdial.[11]

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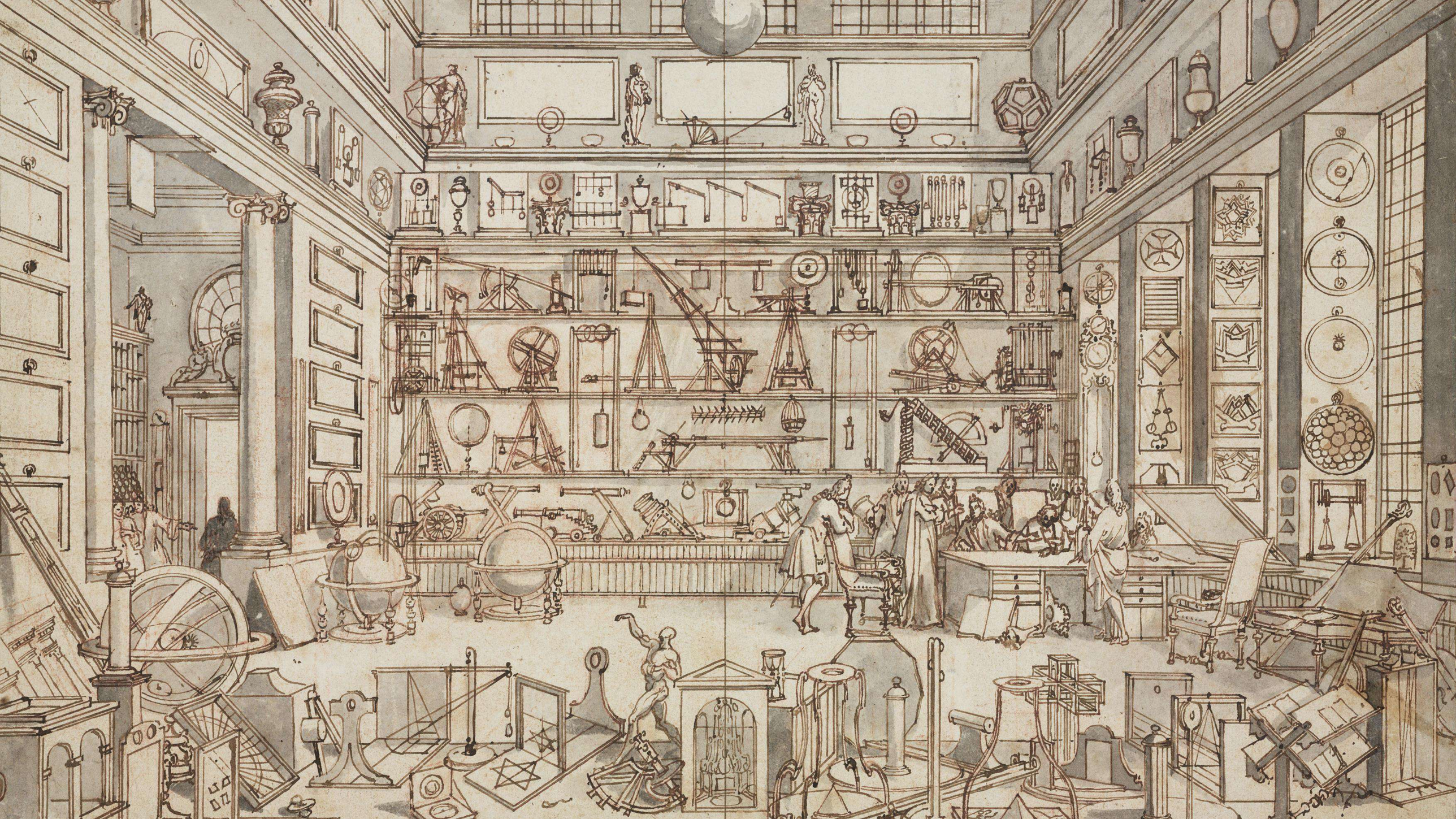


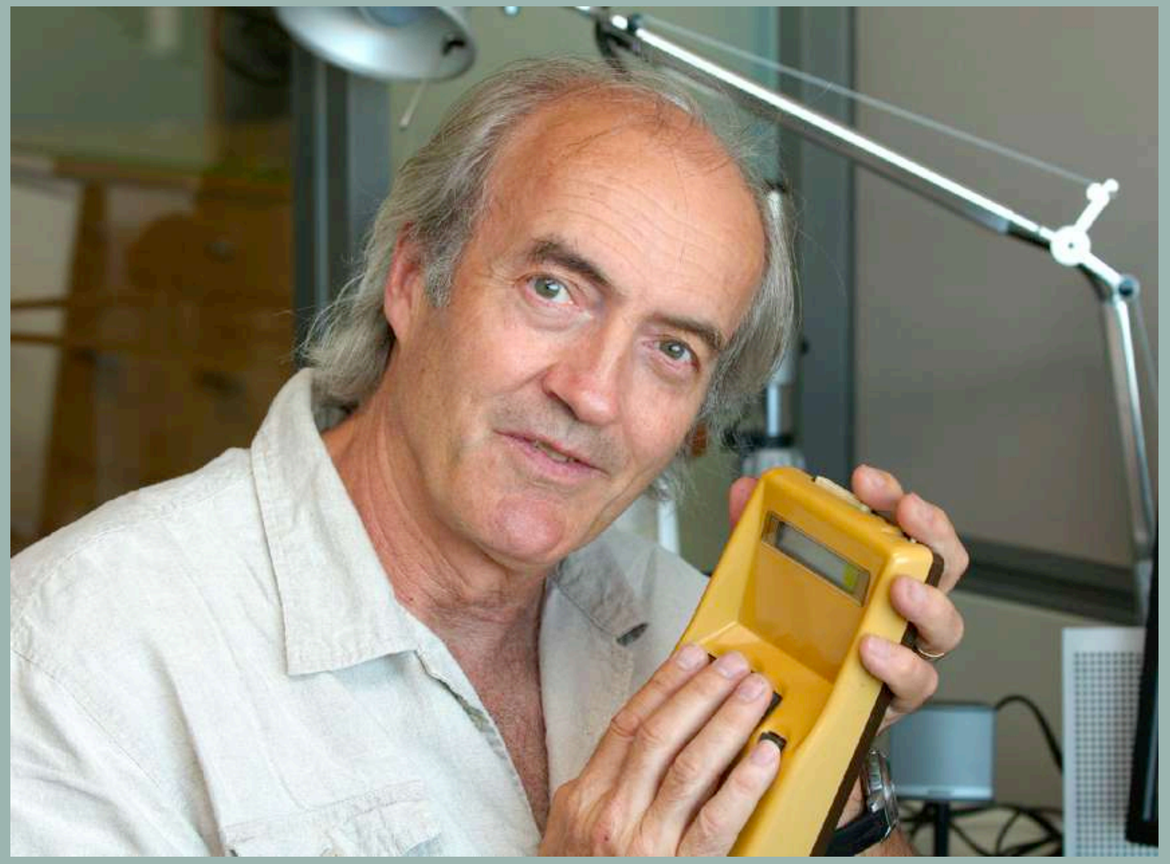
Bill Buxton (UX Designer) on "The Artist Spec"

"In the grand scheme of things, there are three levels of design: standard spec., military spec., and artist spec.

Most significantly, I learned that the third was the hardest (and most important), but if you could nail it, then everything else was easy.

After my work with artists, my research career at the University of Toronto and Xerox PARC was relatively simple."

– billbuxton.com/luthier



The Artistic Live Coder Spec

- Terse (artistic) domain-specific notations
- Instantaneous multimodal feedback
- Ultra low latency and deterministic / hard real-time
- Integration with physical and gestural interfaces
- Focus on immediacy and cultural expressivity
- High degrees of portability and usability

Suggestions for the Cling community

- Become an artistic live coder (you already are one!)
- Join external artistic live coding communities
- Start your own artistic live coding community internally
- Use Cling to make art
- Host an Algorave at CERN
- Share your screens!

Embedded AI for NIME: Challenges and Opportunities

Workshop at NIME 2022

https://embedded-ai-for-nime.github.io/

design strategies ◦ conceptual frameworks

interaction paradigms ◦ neural audio synthesis

AR/MR/VR ◦ mobile computing ◦ AI musicality

dev workflows ◦ interactive machine learning

ethical issues ◦ inclusivity & diversity

Deadline extended to **June 12th**.

Emute Lab ◦ Intelligent Instruments Lab ◦ Augmented Instruments Lab

Discord – iil.is

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European Research Council
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