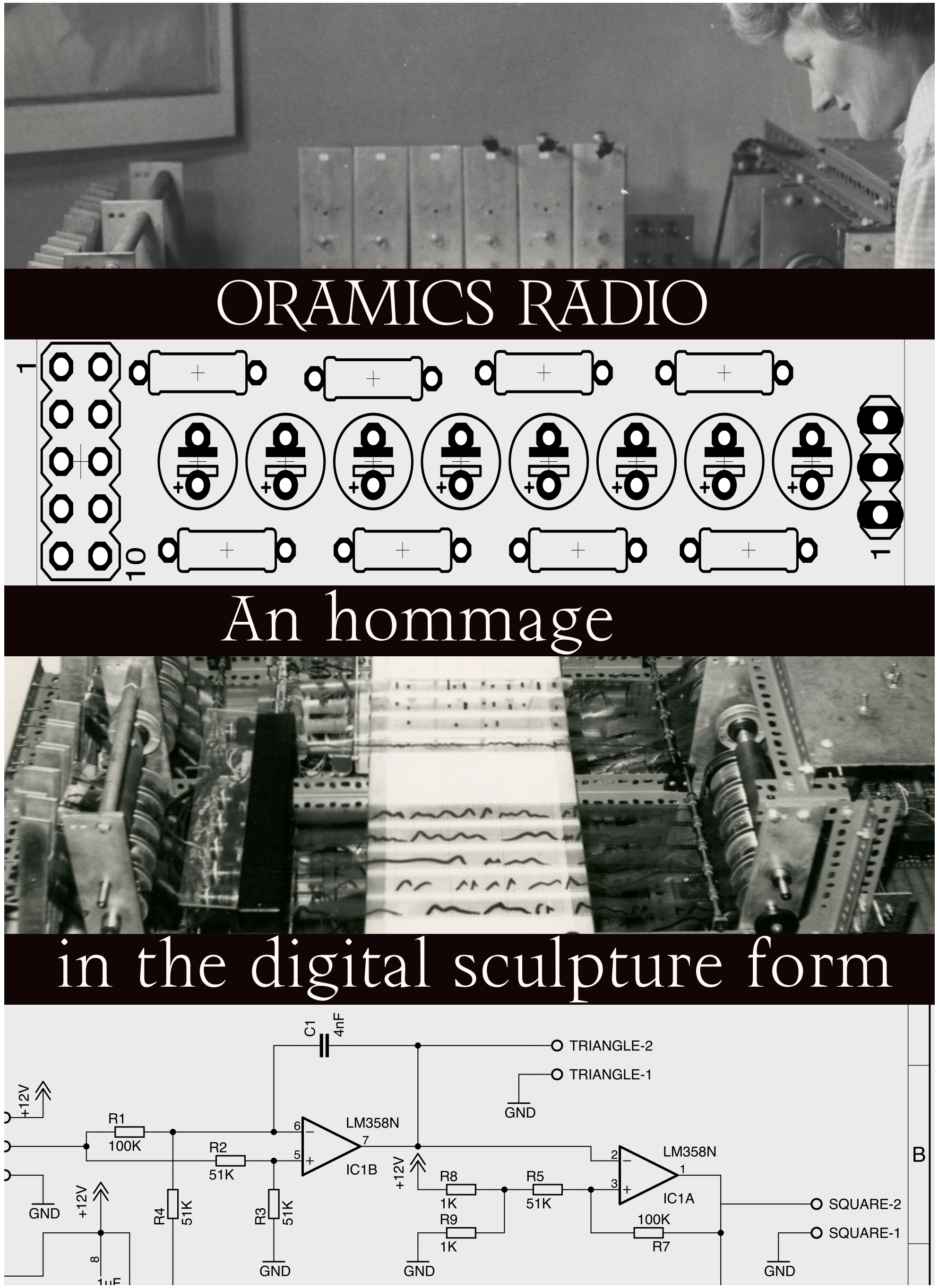


This book is edited by **Grégoire Rousseau** and published in the context of the exhibition **Sculpting Time in Marsio, Aalto University, Helsinki Finland, in April 2026**. The exhibition gathers Aalto sculpture teachers,. I thank Denise Ziegler for the invitation, the organization and energy.

The excerpts from **Daphne Oram**'s book *An Individual Note,* and the Oramics's images in the exhibition were granted permission to use by the Daphne Oram Trust and were provided by the Goldsmiths Library Special Collection Archive. I express my sincere gratefulness to Carolyn Scales for her support and kindness.

ORAMICS RADIO live sound is available online on the audio stream featured on **Station of Commons** website.

The book is published by Station of Commons in a first edition of 50 copies.

Grégoire Rousseau is educator, artist and doctoral candidate in the rAt reseach group, Aalto University.

DaphneOram

STATION OF COMMONS

A! Aalto University School of Arts, Design and Architecture

TAIE

rAt

Space

Goldsmiths UNIVERSITY OF LONDON

Grégoire
Rousseau

ORAMICS RADIO
An hommage
in the digital sculpture form

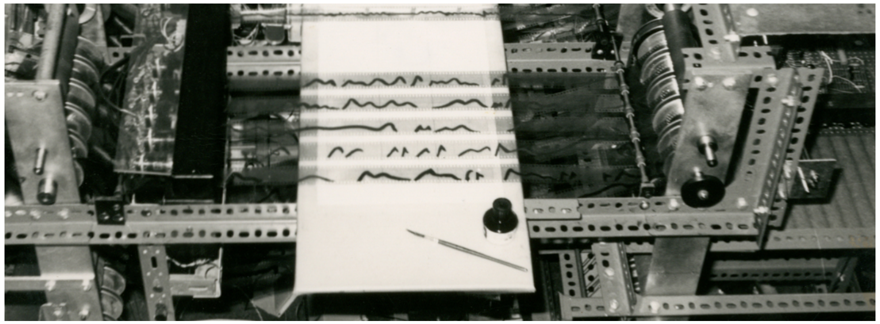


Table content

Introduction

Oramics Radio

I think that I acquired the book An Individual Note of Music Sound and Electronics by Daphne Oram in 2018 in London in an art gallery. I still remember what made my mind to buy it. In the first chapter, I could read this sentence that resonated with my own audio practice.

We shall, therefore, be exploring aspects of electronics and acoustics in relationship not only to the composition of music, but also to the world in which we find ourselves.

This clear statement commits to approach electronics and accoustics together to find an artistic audio form, and that this practice should not be isolated within its own field. The complementarity of electronics and acoustics shows clearly in terms of waves. Electronics is the science, or engineering, of the electrical waves; sine waves, square waves… The loud speaker converts the electrical signal into air waves that our hearing sense perceives as sound. However, what we hear is defined by how we perceive the air waves navigating within a specific space of listening. Acoustics can calculate how certain electronic waves will sound like for an audience within a certain space. Daphne Oram proposes to open this listening space to explore further the fields of electronics and acoustics beyond an enclosed artistic production, toward a social practice of sound. I used the book in my electronic and sound courses. I appreciate the balance between the technical and didactic pages on electronics and music as much as the poetic passages on listening therory. The artwork Oramics Radio reinterprets the Oramics by situating the instrument in our contemporary times. What are the current material conditions to produce a new instrument? How can sound practice explore new space of encounter? How common technology can transform a body gesture into abstract sound and broadcast it further to the world in which we find ourself in?

Oramics Radio departs from these questions. For 20 days, Oramics Radio broadcast live the sound waves produced by the the abstract scores written in the exhibition space using common and Open-Source technologies. This publication edits key elements in the thinking and making process of the work.

Daphne Oram

Daphne Oram (December 31, 1925 - January 5, 2003), was a pioneering British composer and electronic musician. She was the creator of the "Oramics" system, a technique used to create electronic sounds.

Educated at Sherborne School For Girls, Oram was, from an early age, taught piano and organ as well as musical composition. In 1943 she was offered a place at the Royal College of Music but instead took up a position as a "music balancer" at the BBC. During this period she became aware of developments in "synthetic" sound and began experimenting with tape recorders. She also spent some time in the 1940s composing music, which remained unperformed, including an orchestal work entitled Still Point. In the 1950s she was promoted to become a music studio manager and began to campaign for the BBC to provide electronic music facilities for composing sounds and music, using electronic music and musique concrète techniques, for use in its programming. In 1957 she was commissioned to compose music for the play Amphitryon 38. Using a sine wave oscillator, an early tape recorder and some self-designed filters, she produced the score from only electronic sources; the first of its kind at the BBC. Along with fellow electronic musician and BBC colleague Desmond Briscoe, she began to receive commissions for many other works including a significant production of Samuel Beckett?s All That Fall. As demand grew for these electronic sounds, the BBC gave Oram and Briscoe a budget to establish the BBC Radiophonic Workshop in early 1958. In October of that year, she was sent by the BBC to the "Journées Internationales de Musique Expérimentale" at the Brussels World Fair (where Edgard Varèse demonstrated his Poème électronique). After hearing some of the work produced by her contemporaries, she decided to resign from the BBC less than one year after the workshop was opened, hoping to develop her techniques further on her own.

In 1959 she installed her Oramics Studios for Electronic Composition in Tower Folly, a converted oast house at Fairseat, near Wrotham, Kent. Her output from the studio, mostly commercial, covered a far wider range than the Radiophonic Workshop, providing background music for not only radio and television but also theatre and short commercial films. She was also commissioned to provide sounds for installations and exhibitions. Other work from this studio included electronic sounds for Jack Clayton's 1961 horror film The Innocents, concert works including Four Aspects and collaborations with opera composer Thea Musgrave.

In February 1962 she was awarded a grant of £3500 from the Gulbenkian Foundation. These funds supported the development of the Oramics drawn sound technique. A second Gulbenkian grant of £1000, awarded in 1965, enabled the Oramics composition machine to be completed. The first drawn sound compositions using the machine had been recorded by 1968.

Throughout her career she lectured on electronic music and studio techniques. In 1971 she wrote An Individual Note of Music, Sound and Electronics which investigated electronic music in a philosophical manner. Besides being a musical innovator her other significant achievements include being the first woman to direct an electronic music studio, the first woman to set up a personal studio and the first woman to design and construct an electronic musical instrument.

Biography available at the Daphne Oram Archive, Goldsmith University.

https://www2.calmview.co.uk/Goldsmiths/CalmView/Record.aspx?src=CalmView.Catalog&id=ORAM&pos=1

Excerpt from *An Individual Note*, Chapter 11

Chapter 11 MACHINE WITH HUMANISING FACTORS — NOTATION — SEPARATION OF PARAMETERS — ENVELOPE SHAPES — VOLUME — ANALOGUE — TIMBRE — FREEHAND DRAWINGS — BLEND OF TIMBRES WITHIN THE NOTE — PITCH — DIGITAL — NEUMES — OPEN STRINGS — FINGERBOARD — STEADY STATE — FATIGUE — ANALOGUE PITCH — VIBRATO — REVERBERATION — PARTIAL INDETERMINACY — VISUAL ACCOUNT OF THE MUSIC — MONITORING FEEDBACK — 'INNER' EAR — ERASING — HUMAN FACTORS — CONVEY INDIVIDUALITY — MUSARIAN — ORAMICS.

11

We wish to design this machine-with-humanising-factors so that the composer can instruct it by means of a direct and simple language. He will want to transduce his thoughts as quickly as possible, via a channel which is logical.

So let us take each parameter in turn and decide what notation will be suitable. The parameters we will consider are volume, duration, timbre, pitch, vibrato and reverberation. If we think of the **volume** (amplitude) of a musical note we might consider that the terms loud or soft would be sufficient to define it. But when we display musical notes on the oscilloscope screen we see that the amplitude graphs of a 'loud' note, played successively on two different instruments, can be strikingly different. One might be this shape  the other this shape 

These we term **envelope** shapes.

The most straightforward way of notating these two different shapes would surely be to draw them just as I have done—to draw

a thick black line from left to right to show the change in volume, using the base line as 'silence' and the highest possible point as 'very loud'. So bottom to top (the Y axis) is *pp* to *ff*, and the distance from left to right (X axis) is the **duration** of the sound—we could decide on a convenient time scale of 'so many centimetres to the second'. We have thus written an *analogue* of the sound (we have drawn an 'analogy'). Now we require our machine to read this black line and control the volume accordingly.

Control the volume of what? We shall have to consider how we are going to make a sound . . . a sound of exactly the **timbre** we want. We are not going to be satisfied with just those coldly clinical sounds—the electronic sine and square waves, nor even with waves of this  shape, or of this  shape. We are much more likely to want a splendidly curvaceous wave like this  ; using that for the first three notes, then gradually blending it into this wavepattern  during the next 20 notes.

We could do masses of mathematics and work out, by Fourier analysis, how many sine waves we would need to mix together, and at what relative amplitudes they would have to be, to give us those wavepatterns. Then we would have to operate lots and lots of oscillators, turning all the right knobs precisely the correct amount . . . a laborious, tedious job. Or we could take a complex wave-pattern from an electronic generator and filter away all the components that we do not want, in order to retain those that we do require—this is how those clever 'mighty wurlitzers', the Electronic Synthesisers, make their sounds—but, alas, lots more knobs and dials . . . and will we ever get that blend right?

Really it will be much easier if we can take a pen and just draw  and , and get the machine to scan these wavepatterns and give us the equivalent sounds. Just a few notes from each pattern will allow us to check, by ear, that these are really the timbres we want. If, however, we find that we do not like the sounds that these patterns produce, then we only have to draw other patterns and so empirically explore, by visual-to-aural means, the countless possibilities of the many waveshapes that we can imagine and draw. It will all be so much easier, so much more humanised, than turning lots of knobs!

The machine will read the patterns just as soon as we present them to it, so we shall hear the results from the loudspeaker straight away. This is fine, for our 'inner ear' is telling us what we want, and we wish to find the sounds before the inner ear's memory fades, so this speed of operation is a great asset. It is most important to hear, immediately, the aural effect that the volume envelope tracks are having on the timbre shapes, and also to be able to blend and alter the timbre within the duration of a single note.

So far we have given our machine instructions about timbre and volume; now we must tell it the **pitch** of every note. Until now we have given it analogue information to read. If we show the pitch of a phrase of music in a similar way, specifying, say, nine notes by this undulating line , we might have difficulty in accurately defining the exact pitch of each note; for we may want notes ranging over the span of seven octaves or more. We shall need some system that is more indicative than an undulating line.

For centuries, in the musical world, we have been defining pitch by putting marks on and around five stave lines. Can we continue to do that for this machine? If we do decide to give our machine ordinary musical notation to read, we shall have to devise a rather clever machine. It will have to recognise the treble and bass clefs, and recognise sharps and flats and leger lines, as well as the ordinary lines and spaces of the stave. Even when we have devised such a machine we may not find this notation adequate, for we may want to write notes and 'swoops' and trills, using pitches which cannot be shown accurately on the treble and bass staves.

So we will invent another notation system (and make it as flexible as possible). We will have a number of lines on which we put

marks. These marks will be black dots, which we will call **neumes.** Before we start writing each composition, we will tune the machine so that each of these lines means a certain pitch. We could think of the lines as being the open strings of an instrument. These lines can be easily tuned in any way we like. We could tune them in 3rds, or 4ths, or 5ths, or in strange interval relationships like $\frac{27}{19}$ or $\frac{173}{90}$, (outside our normal chromatic scale). Now, if we put one black dot on a line, we will get from the machine the pitch we have specified for that particular 'open string'.

To get pitches between these 'open strings', we will have some more lines, which will be somewhat like the fingerboard of a stringed instrument. Dots on these lines will raise the pitch of the chosen 'open string'. Each of the 'fingerboard' lines will raise the pitch by a pre-set amount: for instance, a semitone, $\frac{1}{4}$ tone, $\frac{1}{8}$ tone, minor 3rd, or any other interval.

We may not want to think in terms of the normal chromatic pitch. We may prefer to set up our 'open strings' to certain frequencies such as 100 Hz, 249 Hz, 370 Hz and 705 Hz, etc., and set our 'fingerboard' to raise the pitch by any ratios we wish.

By writing our black dots . . . neumes . . . on these 'open string' lines and 'fingerboard' lines, we are now giving our machine simple digital instructions regarding pitch. We are giving it instructions to maintain one pitch (frequency) for the duration of one note. But are we right in doing this? We must remember that we are wishing to 'humanise' this machine. Is it 'human' to maintain anything in a steady state for long? Your limbs, your eyes, your voice, your brain . . . do you hold these in an absolutely steady state for a long period? You get fatigued rather quickly if you try to maintain them so. Musical notes are the same: if we maintain them in a steady state for more than a second or so, they begin to produce fatigue. They are much more interesting, and less fatiguing, if their various parameters (especially their pitch) vary subtly throughout their duration.

With our black dots, our neumes, we have defined the basic pitch of the note: we have defined it digitally. Now we want to modify that pitch slightly, giving it a 'waver', or **vibrato**. We do not want a steady waver, a rhythmic vibrato, for this would be unnatural and far too 'electronic' in its nature. We could, very simply, define what we want by drawing an undulating line, something like this . Now our machine will read this undulating line as analogue instructions, and will modify the pitch accordingly.

The music we are instructing this machine to 'play' now has timbre, volume, pitch and vibrato. By drawing more than one timbre wave pattern, and separately controlling the volume from each, we can blend timbres together. So the tone colour can subtly change even within a single note.

What about **rhythm**? Well the volume tracks are giving the duration of each note . . . and of each silence . . . so they are already specifying the rhythm and the accents of the music. If we have a device for introducing **reverberation** (such as an echo room or reverberation plate), we can enhance the sound by using another analogue track to control the amount of reverberation at each moment.

All these analogue tracks are drawn freehand and so are the timbre wavepatterns. In drawing freehand we shall not make our lines absolutely 'accurate'—slight indeterminate factors will creep in, for 'straight lines' will not be quite straight, undulations will have a 'freedom' within the overall form and there will be imperfections. Our own individuality will determine how 'accurate' we wish any parameter to be; some instructions we will draw in with a fast sweep of the hand, with others we may be quite fastidious. So indeterminacy has its place in our machine—it occurs within the overall musical form, which is determined. It adds richness, it confirms individuality.

If we require control by random number series and, furthermore, if we need memory facilities (other than those given by the musical 'score'), we shall have to connect our machine to a small digital computer via an interface and terminal.

Reading all this description of our new musical notation, perhaps makes it sound rather bewildering and complex. I have tried to describe the system in terms which can be easily understood,

without worrying that they may not be strictly correct in terminology . . . in fact, throughout this book, I have remembered a saying of Seneca, to the effect that if one tries to be completely accurate one only becomes perplexing.

Although this notation system may not sound simple, in practice it is very straightforward. The graphs are simple to draw and can be amended or erased; the dots (the digits) for pitch control—the neumes—can be quickly written in. What is more, the overall musical 'score' gives an easily comprehended, permanent, visual account of the music, as well as being the instructions for the machine itself.

At the end of the last chapter we gave ourselves some specifications for our machine. The first facility we required was freehand drawing of all instructions; the second facility—each parameter instructions to be drawn separately. Well, we have coped with those—every parameter is now covered by graphical notation (analogue or digital) and there are separate lines of notation for each parameter.

Number three facility is a monitoring system to allow immediate, or almost immediate, 'feedback' of the result. We have an immediate *visual* feedback of what we are writing in our graphic notation, and as we gradually come to know the 'language', our 'inner ears' will let us 'hear' what we are doing; but we need a real *aural* feedback, too. After writing a few notes we shall want to be able to press a button and make the machine play back to us, through the loudspeakers, just what we have written. We shall want it to read all the parameters at once and give us the result—compute the result. (Or we may require it to keep some of the parameters in a steady state, while we hear what effect the other parameters are giving our sound. We must make the machine as sensitive and flexible as possible.)

When we have heard these few notes we have written, we shall want to be able to re-write our notation . . . one note may need to be a little louder, another note shorter, the blend between two timbres may not satisfy us. We must be able to find the exact point in our notation which needs to be changed. It will be best if we can turn back the music, by hand, until we find the point we are looking for; and then be able to erase it and re-write just that particular parameter only—we do not want to alter the other parameters at that point, for they are working well, and it will be a nuisance if we have to re-write those too. When we have made our slight alteration we shall want to be able to hear it straightaway, and go on adjusting and monitoring, and on and on adjusting and monitoring, until finally the results satisfy that 'inner ear' of ours, which originally conceived the sound.

With those facilities we have completed our original specification. It was a very basic specification and I am sure you can think of many more facilities which would be desirable—it really is rather an interesting line of thought to pursue . . . what are the factors which make us 'human' and how can we 'humanise' the machines around us, so that we can convey more of our individuality through them?

You may be interested in the photographs (pp. 104–7) and diagram (appendix) because they show the machine I have been describing. I spent many years thinking about it and designing it, and then, through a generous grant from the Gulbenkian Foundation, I was able to buy the components and set to work to build it.[1] I have been building it in rather the fashion I compose music—I have 'led it through' and allowed it to evolve. Indeed, it is still evolving all the time, for one lifetime is certainly not long enough to build it and explore all its potential.[2]

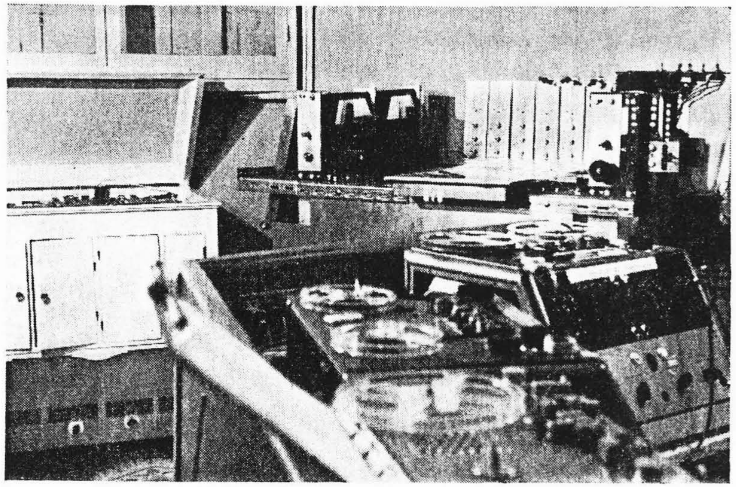
The system (which is nowhere near as costly as the computers we talked about in Chapter 9) is based mainly on controlled feedback and the computing of resultants. It seems to give hints of how some aspects of the human being 'work'—perhaps even hints of how parts of the brain function. It leads me to much musing, and, being no expert, I enjoy a freedom for experiment and thought which an academic approach might well inhibit. Sniffing the air to catch new scents is to me one of the happiest ways to spend one's life, and, if the scents lead me sometimes 'up the garden path', I still enormously enjoy catching them.

(Remembering the Italian word *MUSARE*, do you think I should call myself a *MUSARIAN*?)

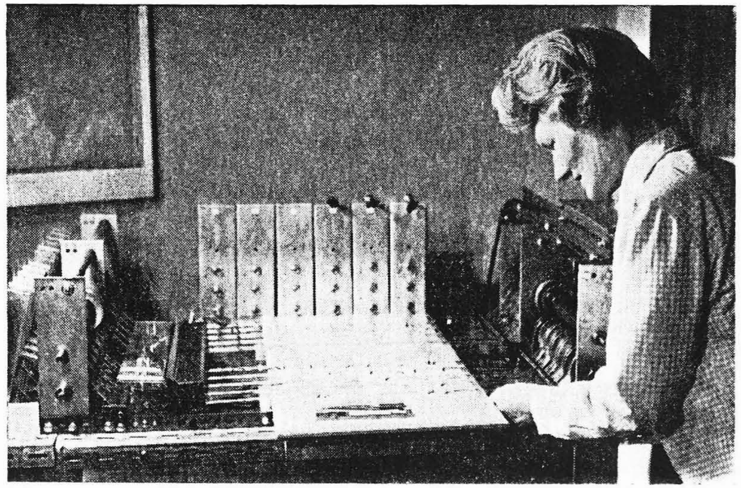
My machine does not really fit into any category, nor does the notation system which goes with it, nor does the music which comes from it. It is a control system which could be applied to many fields, as well as music. I have therefore coined the word O R A M I C S for it . . . and for its philosophy.

1 Now patented.

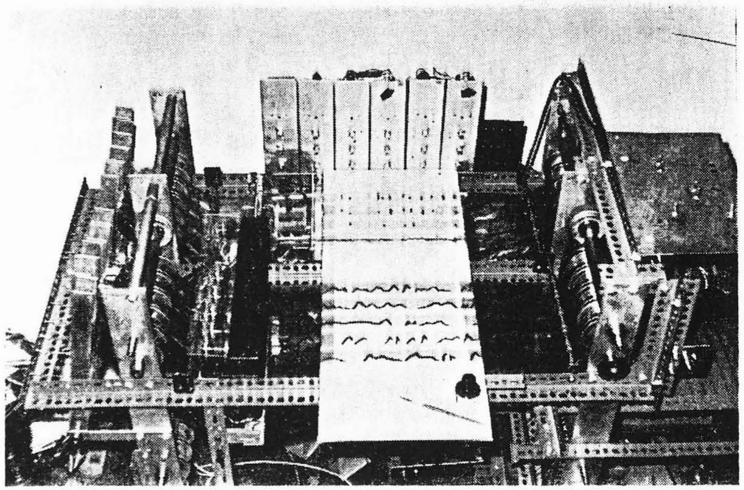
2 *See* Appendix for lists of tapes.



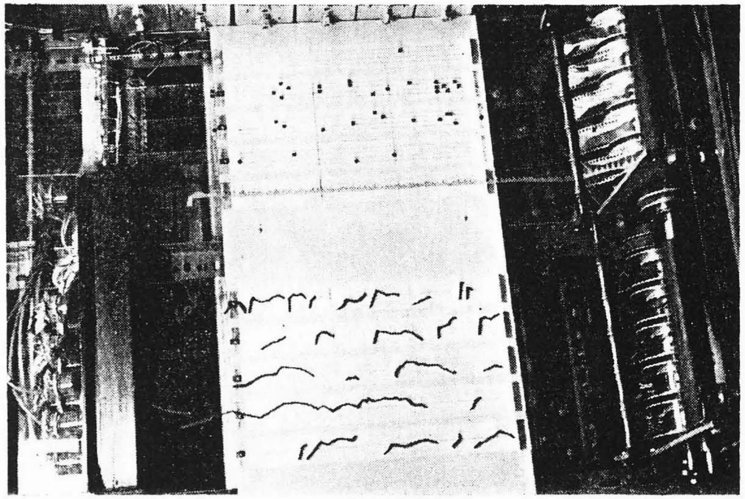
1. Looking across Daphne Oram's studio—Oramics equipment in the background, in the foreground Nagra and Brenell tape recorders.



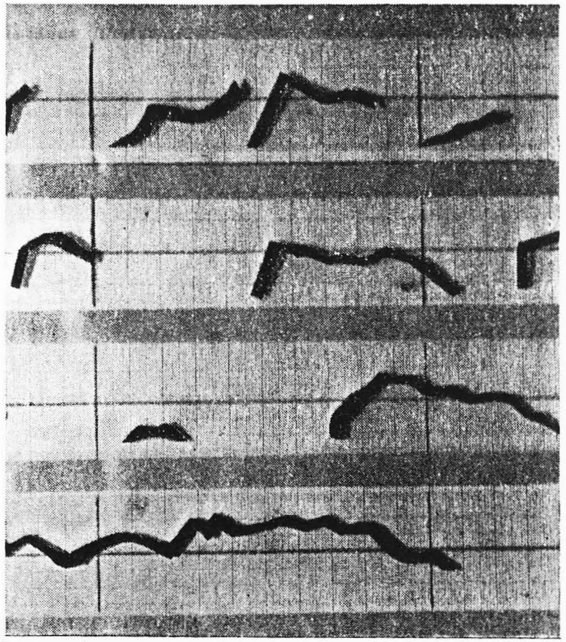
2. Daphne Oram with her Oramics equipment.



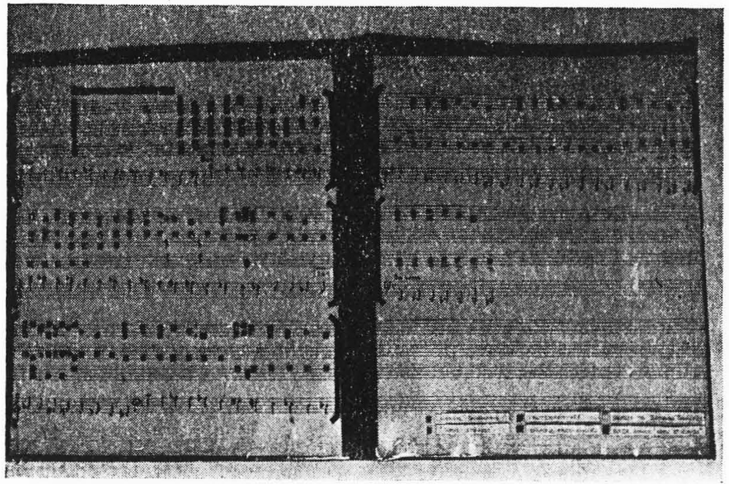
3. Programming equipment.



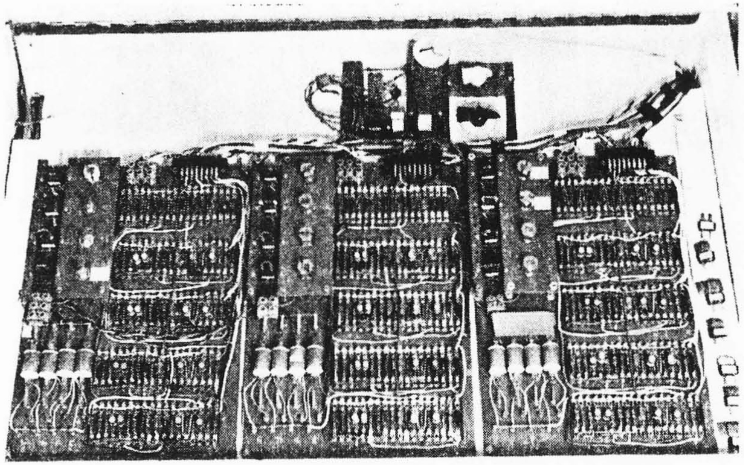
4. Oramics programming equipment—analogue and digital tracks.



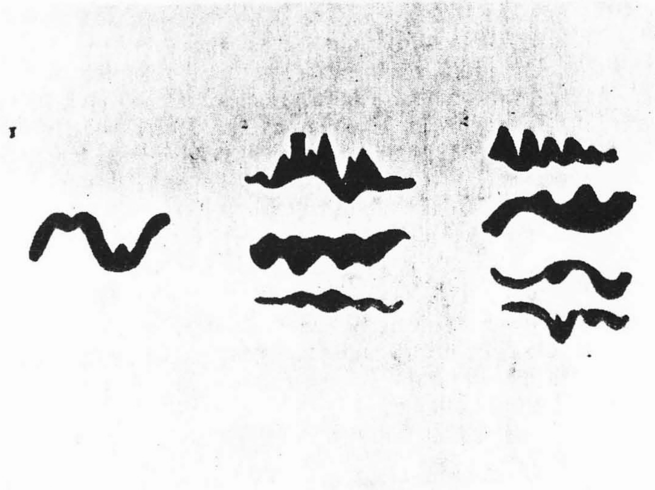
5. Analogue volume tracks—giving envelope shape, duration (rhythm) and volume variations.



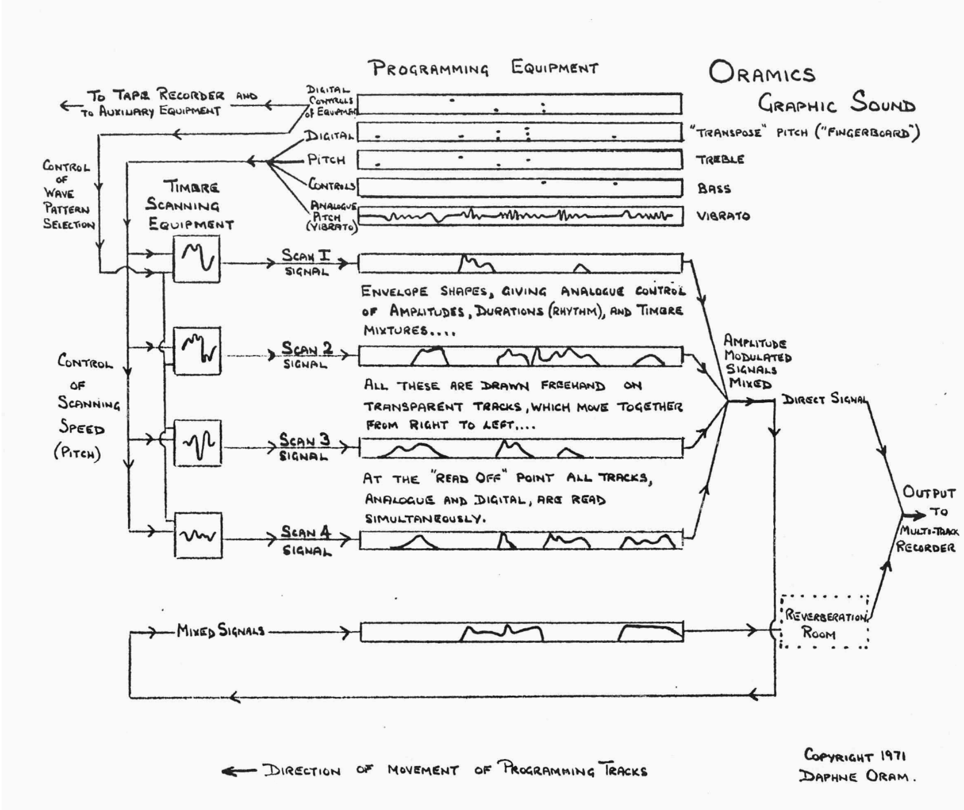
6. Notation of pitch for Oramics—a reference book of Neumes.



7. Pitch control circuits.



8. Timbre waveshapes—drawn on transparent slides.



Technologies

The technological and technical process followed a classical path. First comes the **time to research**(P.Horowitz & W.Hill, The Art of Electronic) to find a set of possibilities to implement the desired functions needed to be achieved. Then, I proceeded with digital simulations of the analogue parts. I used **LTspice** by Analogue Devices, it provides quite accurate results in audio. After, I went for the design part. I used my dear and outdated **Eagle Cad Software** for the shematic and printed circuit board designs. Finally, I sent the files to **JLCPCB** for manufacturing and I was ready to solder and test it all in the laboratory.

An **Arduino Mega** handles the digital process. It is reliable and relatively easy to program. This micro-controller platform proves to be the perfect choice for this type of application; lot of digital inputs/outputs, a ready made analogue to digital converters, serial ports, pwm outputs...

The radio part is implemented on the **Raspberry Pi 400**(RPI400). The entire computer is inside the keyboard. This small computer manages the audio capture from the mixer and stream the audio, thanks to the amazing software **ffmpeg**, to Station of Commons **Icecast** infrastructure. I use **Raspberry Pi Connect** software for remote access to the RPI400.

Manual

Welcome to the ORAMICS RADIO!

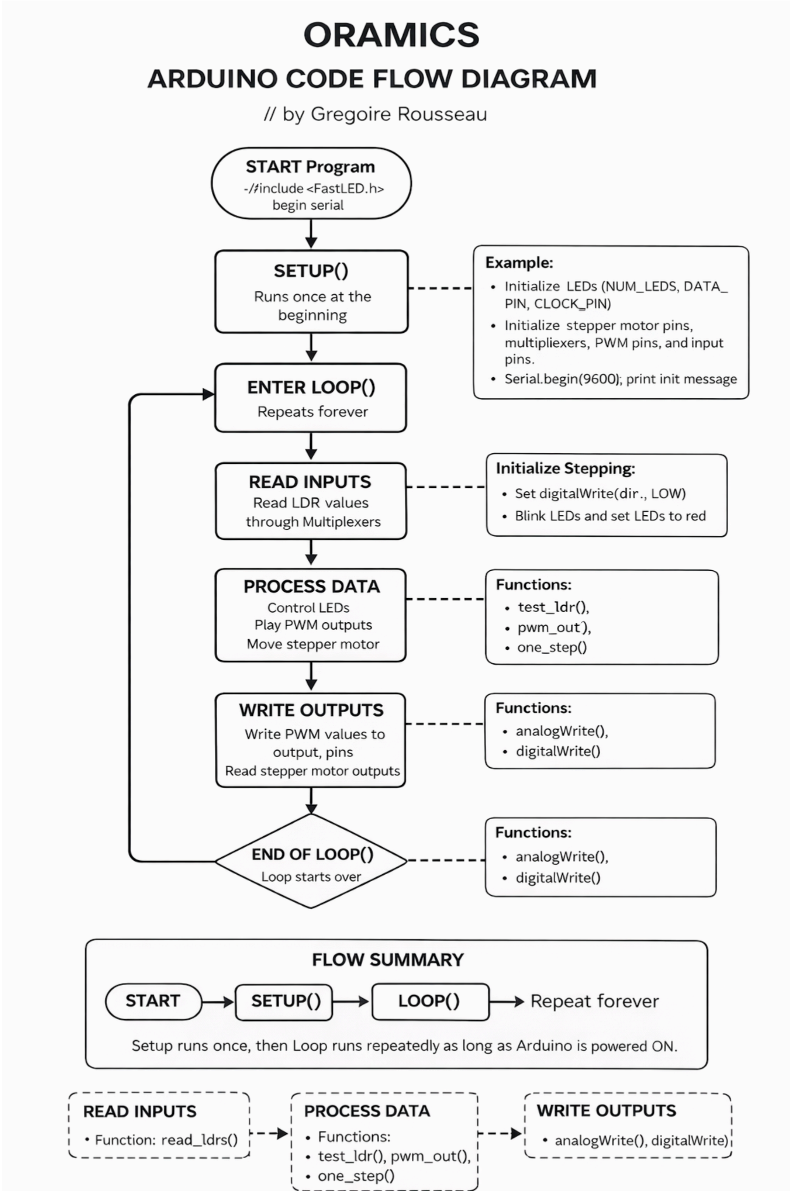
1 You have a decision; either you take a ready made A4 transparent sheet score or you can hand-draw your own from a blank sheet. Use the oil-based ink pen on the table.

2 set your score properly on the glass, on top of the device

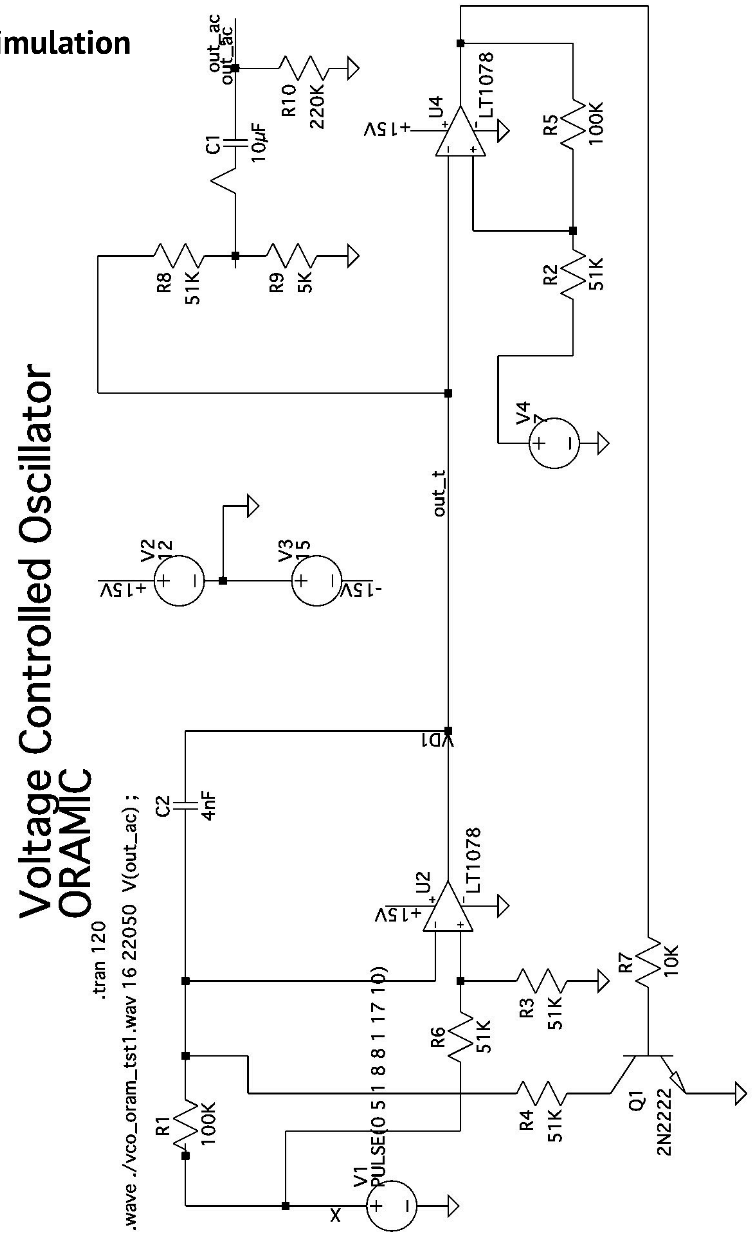
3 Press the green switch on the side of the device

4 Listen to your handwritten score from the speaker or the radio stream.

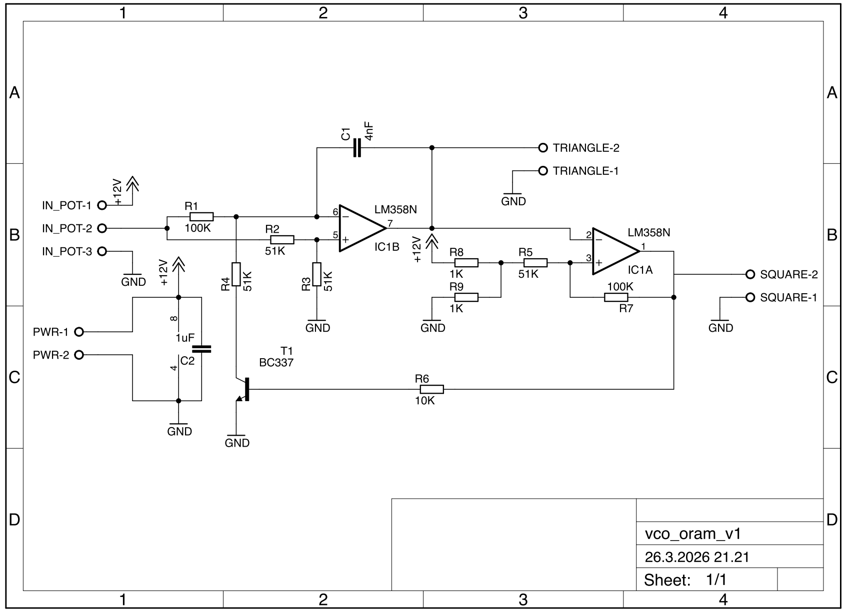
Arduino



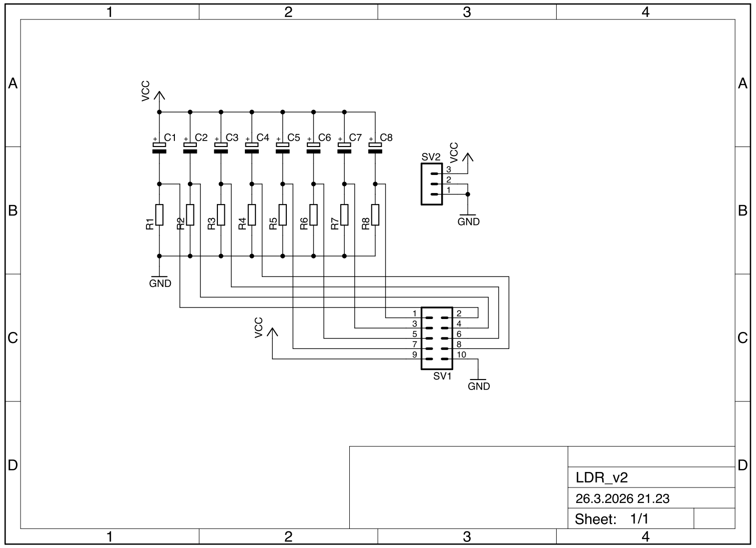
SPICE simulation



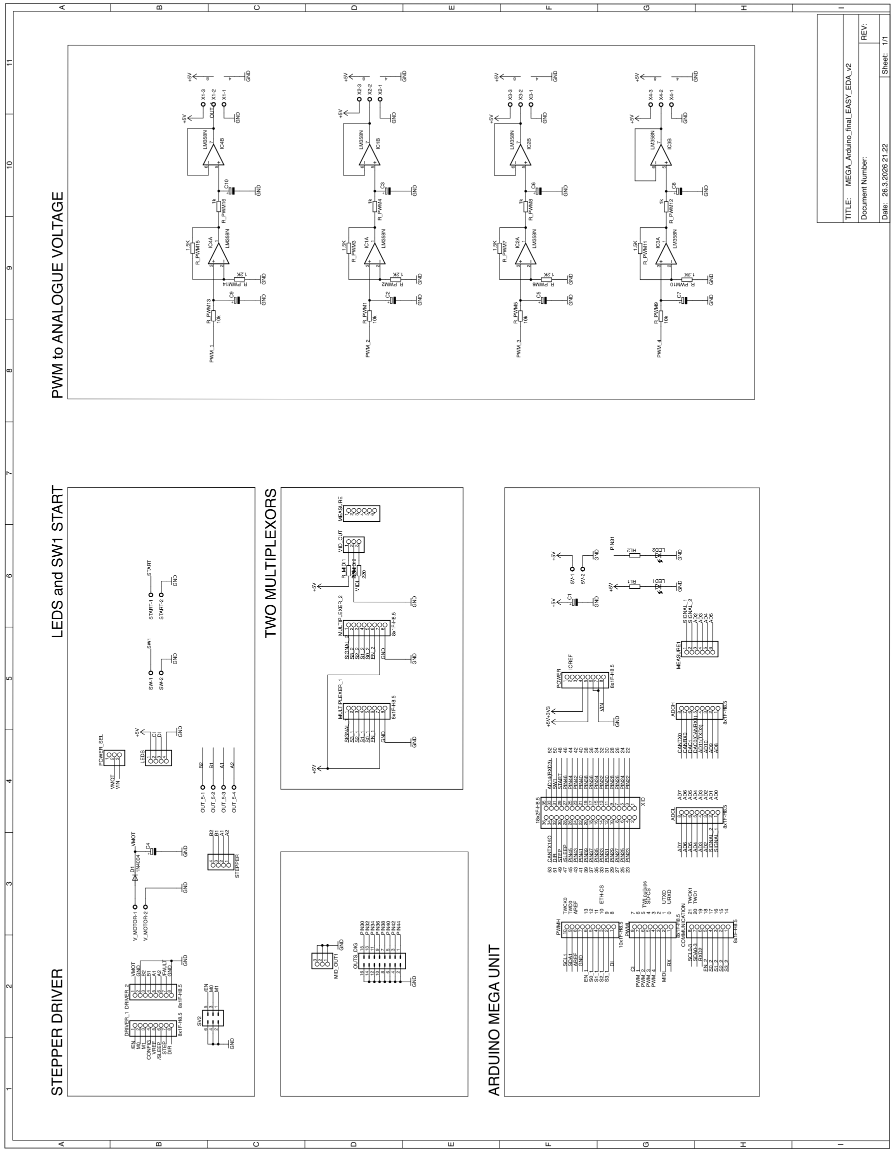
Schematics



Schematic for Voltage Controlled Oscillator, inspired from the Arts of Electronics.

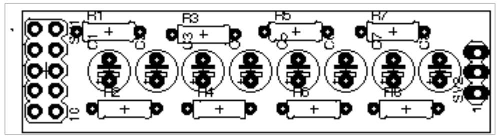


Schematic for Sensor board, 8 LDRs and resistors.

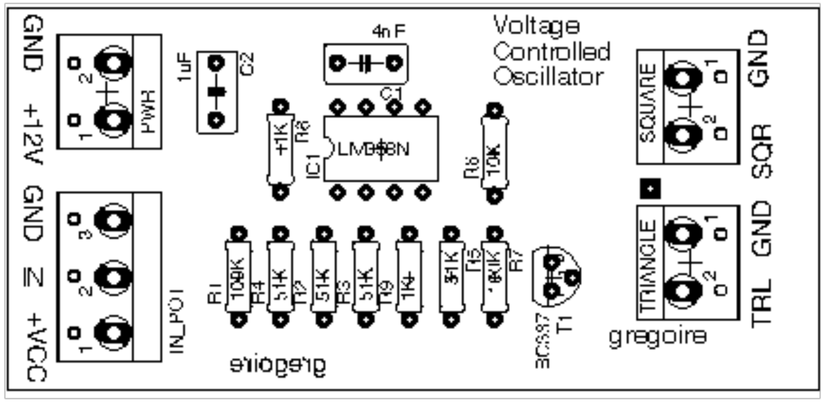


Schematic for the main circuit board to control the stepper motor, LEDS, MIDI and output analog voltage.

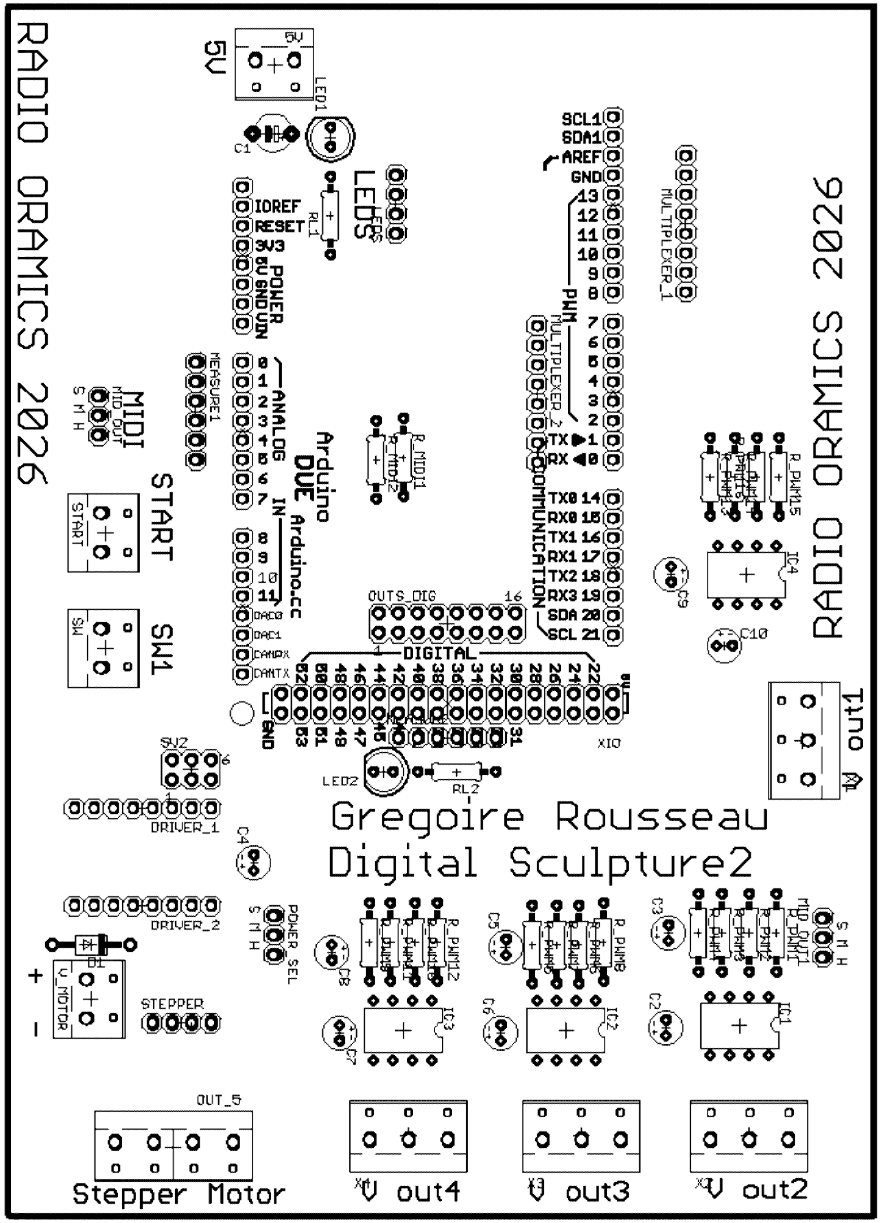
Printed Circuit Board



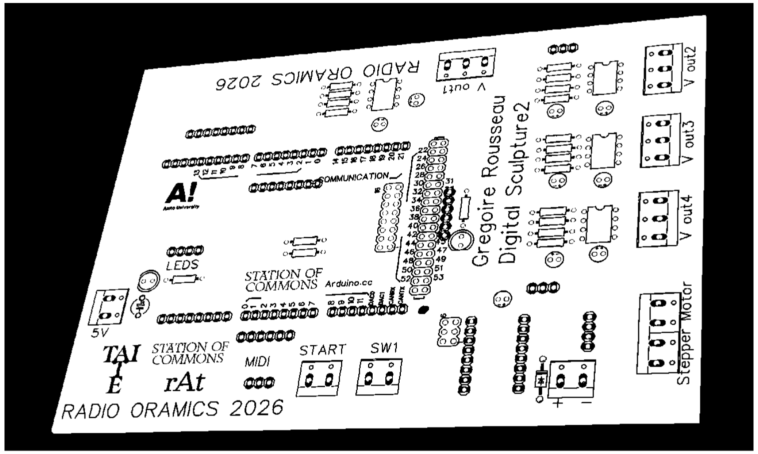
PCB for Sensor board, 8 LDRs and resistors.

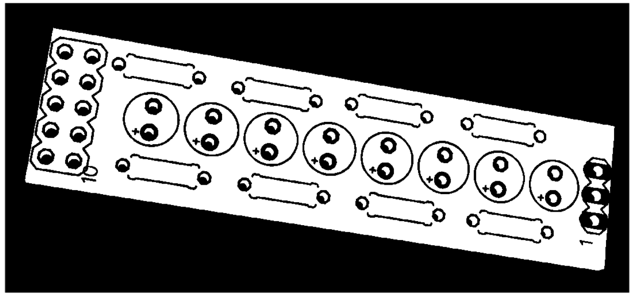


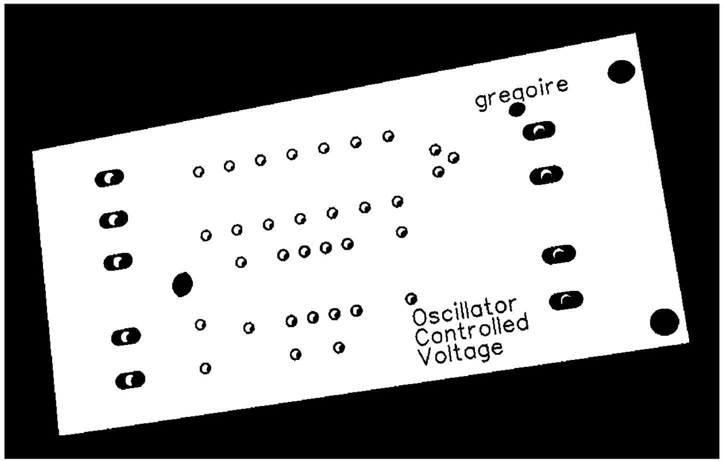
PCB for Voltage Controlled Oscillator, inspired from the Arts of Electronics.



Main circuit board to control the stepper motor, LEDS, MIDI and output analog voltage.







The radio stream with ffmpeg on RPI 400

ffmpeg command line.

HARDWARE	
Serial number	10000000e11ac5e8
Model	Raspberry Pi 400 rev 1.0 (4 GB)
Operating system	Raspberry Pi OS 13 (Trixie)
Kernel architecture	aarch64
CONNECT CLIENT	
Version	2.10.0
Last seen	Online
Screen sharing	Allowed
Remote shell	Allowed

Raspberry Pi Connect configuration.

Acknowledgement

Following the technical and material part of the process, I want to highlight the amazing support provided by the workmasters and technicians in the department. First, the ORAMICS RADIO work would never bever been possible without the mecatronics workshop. Workshop master **Janne Ojala**, assissted by **Villis Zuromskis** and **James Chen**, both brought great technical expertise, shown great understanding throught out the failures and successes along the artwork making. The metal workshop masters, **Teemu Mäntylä** and **Maria Mastola**, do not talk so much, they prefer to master their quality tools. I had the chance to follow the induction for the metal band saw, the metal board cutter. Thanks for that! I printed,at the printlab after completing the online form. I used the self-use printers after 5pm. Thanks to **Eddie Choo Wen Yi** for support.

Once more, I thank personally **Carolyn Scales** and the **Daphne Oram Trustees** for the permission to use the part of the book An Individual Note, the Goldsmiths Special Collection Archive for the high resolution images, and **Matt Price**, Anomie publishing house.

I acknowledge that the artwork departs from the invitation of **Denise Ziegler** to particpate in Sculpture Time exhibition. Thanks for that! The artists are **Marjukka Korhonen, Denise Ziegler, Ari Björn, Satu-Minna Suorajärvi, Jukka Lehtinen, Grégoire Rousseau**.

Nothing would be possible without my dearest **Emilia, Anaïs, Felix and Mathilde**. Also, I think of You all in South of France.

https://www.aalto.fi/en/events/sculpting-time-a-contemporary-sculpture-exhibition

http://www.anomie-publishing.com/coming-soon-daphne-oram-an-individual-note-of-music-sound-and-electronics/

https://www.stationofcommons.org/events/radio-oramics/

https://www.daphneoram.org/

The artwork space “ORAMICS RADIO“ brings to light the work of Daphne Oram(1925-2003), the British female pioneer of electronic music, and find form departing from her Oramics device. As early as 1948, Oram began to design special elctronic equipmentfor audio experiments. She was the first to compose an electronic soundtrack for the BBC television. Oram built her own electronic music system: theOramics. The Oramics device can translate hand written score into electronically generated soundscape. The origin, concepts and operation of the system is presented in Oram's book “An Individual Note of music sound and electronics“. The Oramics device was designed in 1962-69 and operated only with electromagnetical and analogue electronic components. The artwork “ORAMICS RADIO“ re-intreprets the Oram's audio instrument using contemporary electronic components and argues for the sculptural element and value of the device. Oram used the equipment availbale at the time. I propose to build a new version of the Oramics using digital technology and nowadays common prototyping platform such as Arduino. The new version implement common laboratory components such as light sensor, motors and mecatronics. The artwork will be the size of a copy machine, and the electronic and mechanical parts will be visible. The audience can experiment with the device and produce soundscape in the space and on a live internet audio stream. This text was written six months before opening.

DaphneOram

STATION OF COMMONS