MUSIC, TECHNOLOGY AND INNOVATION
RESEARCH CENTRE

Music for DIY Electronics

A collection of workshops, pieces and projects

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interfaces

DE MONTFORT UNIVERSITY LEICESTER

Music for DIY Electronics
A collection of workshops, pieces and projects

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9. Cardboard Box Amp
#Amp #Speaker #Portable #Battery-powered #Gesture #Movement #Space #Environment #Sound diffusion #Doppler effect

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Introduction

These workshops, pieces and projects can be approached in many ways and used in a variety of different contexts.

The collection attempts to break down the barrier between workshop and stage, rehearsal room and lab, and considers music for DIY electronics as an holistic practice. Workshops and related pieces are viewed as singular projects.

Music for DIY Electronics consists of a circular process of ideas, listening, making, and playing.

Maxim: What is good for children is good for adults. The projects are not for a specific age group or demographic. Each project is extensible. A novice or young child can pick up a project from the start, whilst there are suggestions to extended projects through ideas and adaptions.

This collection is made up of a mix of projects that have existed in various forms - tried and tested, and, in many ways, stood the test of time - and new workshops and pieces that have been especially written.

The projects focus on available, at hand resources and affordable materials.

Given the diversity of situations in which these projects may occur, there are no definitive workshop plans or step-by-step guides. Any person wishing to engage in these projects may jump into the circular process at any point. For example, a starting point could involve listening to the referenced music of each project, or making an electronic sound circuit.

Music and making can be done individually or as a group.

Many of the ideas and techniques presented in the projects connect to broader themes relating to electronic and computer-based music. This includes sound-based music making: music that is not necessarily tonal or even note-based. The making of instruments or sound devices is also seen as part of the composition process, a defining aspect of music for DIY electronics.

Templates
There is a template for each project that contains tags or keywords and a brief description followed by four main areas of exploration: listen; make; play; expand. Each of these areas can serve as standalone workshops or events, be combined or spread across multiple sessions of any duration.

Categories
Borrowing from Richards' and Landy's *On the Music of Sounds and the Music of Things* (publication pending), the projects are grouped into five main categories: Music of Objects; Music of Things; Music of Touch; Music of Actions; and Music of Space. A very brief introduction is given for each category. Categories, however, overlap and should not be considered strict.

Listen
Each project has a short listening list that is designed to help place the project in a broader context. The listening pieces may demonstrate a particular characteristic of a sound device or musical idea of a project. The project tags are used to illustrate related musical ideas of the listening pieces.

Make
A brief overview of the making is given. More detailed explanation of the project builds is given in appendices and online links. Making involves a range of hand tools and skills covering electronics and programming as well as general craft techniques. Certain tools require different ways of thinking and working. Within the projects there is close work (soldering) through to more physical actions (hammering nails). There is an emphasis on the ‘theatre’ of workshops and the ‘choreography’ of building. For example, the building process itself can be thought of as a dynamic group event that is shaped over time.

Play
An accompanying book of scores for *Music for DIY Electronics* (pending publication) is referenced. These scores, written by a range of musicians, are for the sound devices, circuits and ideas described in the projects and act as supporting materials. They may be viewed as starting points for new pieces or springboards for ideas. However, these scores should not be seen as a set repertoire or musical canon. Music is to be found in the making process and the sound-making materials. This applies to all projects.

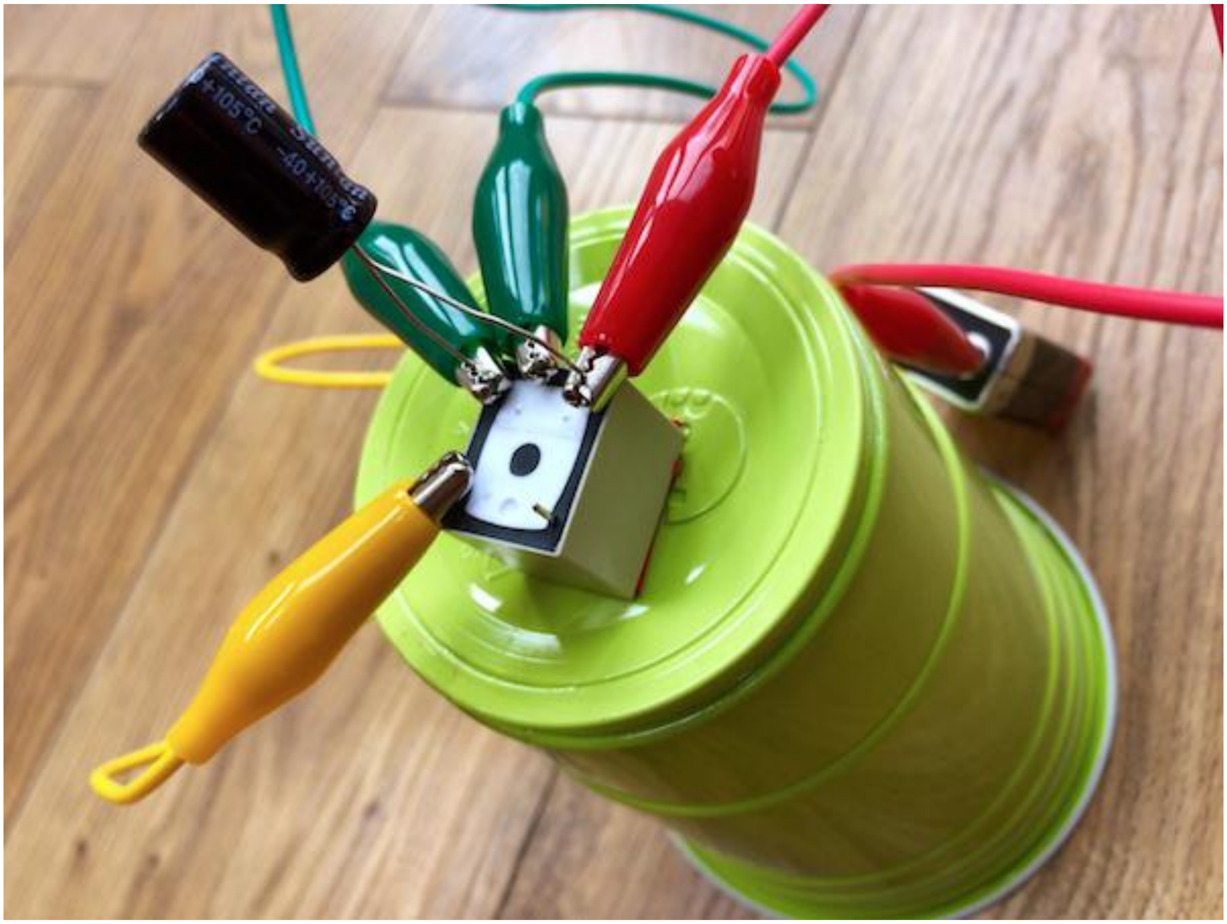
Expand
The projects may be expanded through the circular process of ideas, listening, making, and playing. But, there are specific examples given for the expansion/development of the making process. Many of the sound-making devices are not fixed as such, but can be considered as a typology, approach or methodology. In this context, music and making remain emergent.

Online resources, videos, recordings and images are used throughout in the documentation.

Additional resource materials - ‘How to’ guides etc. - may need to be sought to complete some of the projects. This includes musical and technical materials. For example, there is no information on how to solder or, equally, how to play as an ensemble.

John Richards 2018

Electro-Cricket



TAGS

#Oscillation #Resonance #Percussive #Rhythmic #Repetition #Phasing #Electromechanical #Solderless #Analogue #Relay #Capacitor #Crocodile clip #Prototypic

BRIEF

Make complex beats, rhythms, pops, clicks and chirps with a swarm of Electro-Crickets! This instrument uses a common relay to produce low frequency oscillations. Sound emanates from the case of the relay. By placing it on various objects, you can amplify and shape the sound being produced. You can also vary the frequency of the oscillation using capacitors: the larger the capacitor the lower the frequency. The Electro-Cricket can be built using crocodile-clips, so you don't need to solder anything. This makes it suitable for novice builders and it allows the circuit to be dismantled or changed easily.

LISTEN

Clapping Music (1972) - Steve Reich

Opera with Objects (1997) - Alvin Lucier

Rainforest (1968) - David Tudor
https://www.youtube.com/watch?v=vj1WTsEPcG0

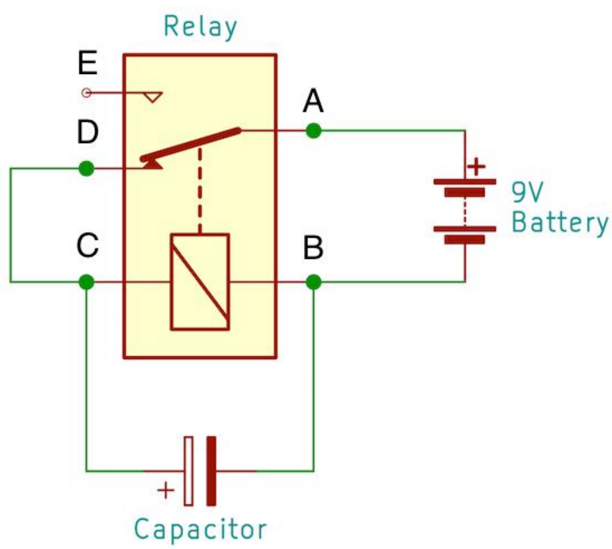
MAKE

Video example: https://www.youtube.com/watch?v=BhgVgZ_eBSs

Materials:

- 9 Volt Battery
- Crocodile Clips (3 per instrument)
- 9 Volt DC relay (with a normally closed connection)
- A selection of electrolytic capacitors (100µF, 470µF, 1000µF)
- Electricians tape
- Hot glue

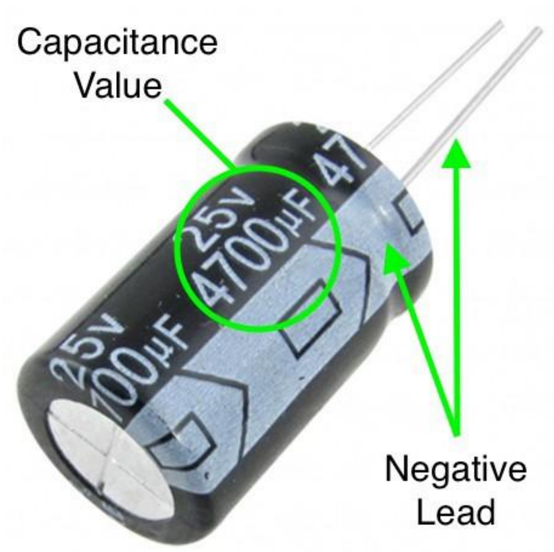
Circuit Schematic:



Relay Pins:
A. Switch Common
B. Coil
C. Coil

D.	Switch Normally Closed
E.	Switch Normally Open (not used)

Capacitor Diagram:



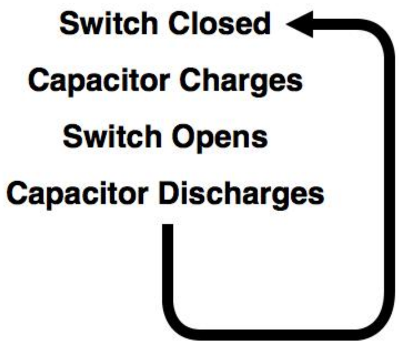
** The negative lead is identified by the grey strip along the side of the body.*

Construction Notes:

Use a Crocodile Clip to connect the positive terminal of the battery to pin A on the relay. Use another clip to connect the negative terminal of the battery to pin B. Use the last clip to connect pins C and D together. The negative lead of the capacitor connects to pin B and the positive lead connects to pin C. Wedge the capacitor's leads into the clips you have already connected to pins B and C. Make sure you don't have any of the clips accidentally touching each other. If the battery becomes hot, disconnect it immediately and start over with the connections.

How it Works:

Inside the relay there is an electromagnet and a spring loaded switch. When power is applied to the coil of the electromagnet, it flips the switch and generates a clicking sound. By connecting power to the electromagnet through the switch, we can create a feedback loop, which causes the relay to oscillate. The frequency of the oscillation can be set with a capacitor. The larger the value of the capacitor, the longer it takes to charge and discharge, and the slower the relay oscillates. To increase the frequency of the oscillation you can make the value of the capacitor smaller.



** Diagram of feedback Loop.*

Initially the switch is closed, the capacitor is discharged and the electromagnet is turned off. In this state, current flows from the battery, through the switch and to the capacitor. As the capacitor charges up, the electromagnet begins to turn on. When the charge on the capacitor is great enough, the electromagnet is powerful enough to overcome the spring holding the switch closed. The switch is now open and the battery is disconnected from the capacitor. The capacitor then discharges, the electromagnet turns off and the spring returns the switch to the closed position. The cycle then repeats itself.

PLAY

Stick them to different objects such as cardboard boxes, ceramic plates, glass bottles, plastic or paper cups, a metal filing cabinet, drum.

Katydid Swarm: (multiple instruments, different resonators and different frequencies, slowly adding one sound at a time, building up a chorus, then slowly removing one at a time)

Katydid Phases: (2 or more instruments, same frequency circa 1 second, start all instruments at the same time, leave the oscillators to play for a while, let them drift in and out of phase)

Katydid Swarm (Electro-Cricket) (2017) - Jim Frize
Katydid Phase (Electro-Cricket) (2017) - Jim Frize

EXPAND

Playing with other instruments
Adding an LED
Building a permanent instrument with variable frequency (buttons and different size caps, fixed to a resonator)
Amplifying and processing the sound

Guinea Pig

TAGS

#Amplification #Resonance #Acoustic #Electro-acoustic #Gesture #Object #Percussion #Microphone as instrument #Found sound #Friction

BRIEF

Guinea pig. What’s that? It’s a cork in a bottle! Lick the cork to make it squeak. The guinea pig is inspired by the Audubon Bird Call. This caller is a small hand-held wooden cylinder with a metal plug that when twisted produces a range of bird-like sounds. The sound is made through friction and the rubbing together of the two surfaces. However, similar results can be produced with a wetted cork in a bottle, except the sounds are more reminiscent of a guinea pig rather than a bird. The guinea pig can be played acoustically or amplified using a contact microphone. This project does not attempt to re-invent the contact microphone, but highlights how a range of everyday objects and found sounds can be explored and discovered through amplification.

LISTEN

Variations II (1961) - John Cage

Sharon Gal's Happening (2007) - Adam Bohman
https://www.youtube.com/watch?v=CKvCxaixheY

Mixtur (1964) - Karlheinz Stockhausen

KCRW Radio, Episode 44: Contact Milk - Produced by Lawrence Dunn.
https://www.kcrw.com/news-culture/shows/the-organist/episode-44-contact-milk

MAKE

Materials:

- Piezoelectric disk (with soldered wires)
- Shielded cable
- Jack socket or plug
- Insulating electrical tape
- Glass bottle (other materials may be used)
- Bottle corks

Construction Notes:

Piezoelectric disk come in different sizes and are relatively cheap. They are made from a thin layer of crystals fixed to a brass disk. Select a disk that will attach to the surface area of your object to be amplified. It is possible to file the disks to a specific size and shape. Use a disk with wires already attached. Most piezoelectric disks have two wires connected to the disk: metal outer (ground/black); inner crystal (signal/red). Strip some shielded cable. The inner core connects to the signal/red, whilst the braided shield should be twisted together and connected to the ground/black. Wrap insulation tape around the wire connections. A jack socket or plug should be soldered to the other end of the cable with the signal to tip and the ground to sleeve. There are many online guides and references for building a contact microphone.

How it Works:

The contact microphone picks up vibrations that run through a surface. The better the contact with the surface, the better the microphone pick ups the vibrations; hence the name contact microphone. The contact microphone works differently to a traditional microphone where vibrations are transmitted through air and detected by a thin diaphragm of the microphone. The contact microphone can be attached to a surface using, for example, tape, Blu Tack, glue or a clamp. Be careful when using tape on the crystal side of the disk. Removing the tape can damage the crystal.

PLAY

Find a bottle to fit a cork; or a cork to fit a bottle. The cork needs to fit snuggly, but not be too tight to prevent the cork/bottle from being freely twisted. Slightly tapered corks work best. The cork should be licked or wetted. As the cork dries and is worked in through twisting, sound will be produced. The cork may need to be re-wetted intermittently. Plastic ‘fake’ corks can also be experimented with.

Find many bottles and corks and play as an ensemble. Attach contacts microphones to the bottles and amplify.

Guinea Pig (2017) - John Richards

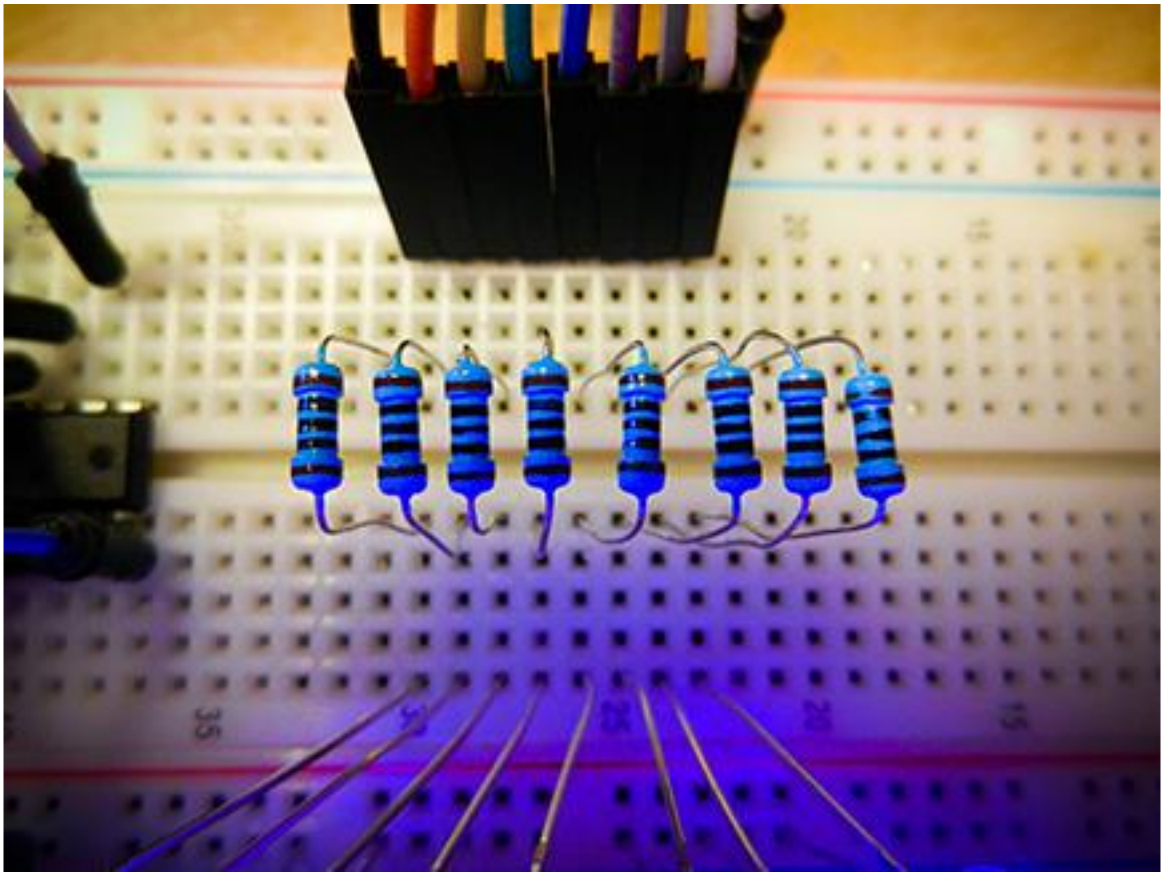
EXPAND

Add a contact microphone to the Lady Bracknell, another ‘friction’ instrument by Hugh Davies.

Attach a contact microphone to a table and create a rhythmic piece by tapping on the table.

For better low frequency response, build a high impedance amplifier to go with your contact microphone.
http://www.richardmudhar.com/piezo-contact-microphone-hi-z-amplifier-using-a-fet/

Live Breadboarding



TAGS

#Breadboard #Prototypic #Oscillation #Modulation #Synthesizer #Solderless #Analogue #Patching #Liveness #Live #Performance

BRIEF

Build and connect multiple oscillators together on a solderless breadboard. Normally breadboards are used as a way to prototype or test a circuit. They make it easy to change connections and swap components. As a result, breadboards are a great tool for making a low-cost patchable synthesiser. In the project circuit, changing the value of resistors and capacitors can vary the frequency of the individual oscillators. Oscillators can then be connected to each other to create various tones, pulses, modulations and complex sounds. The breadboard offers the possibility of making as performance and how patching and constructing circuits may be seen as performative.

LISTEN

Loud Objects live at Bent Festival in New York (2007) -
https://www.youtube.com/watch?v=U1TZ0gMGmVU
http://www.loudobjects.com/

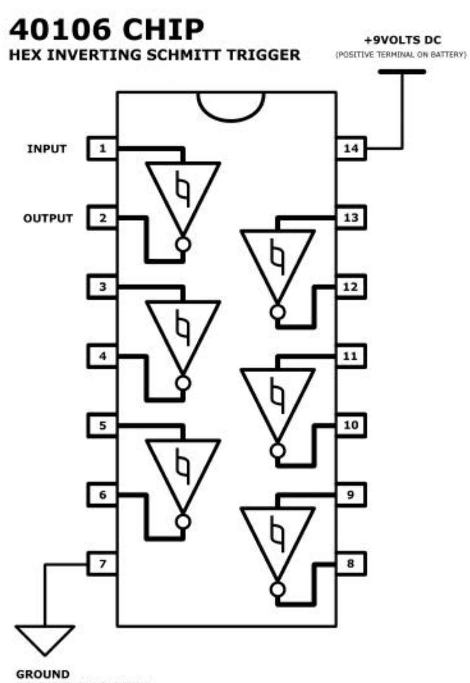
Breadboard band
http://www.breadboardband.org

Live coding
https://slab.org

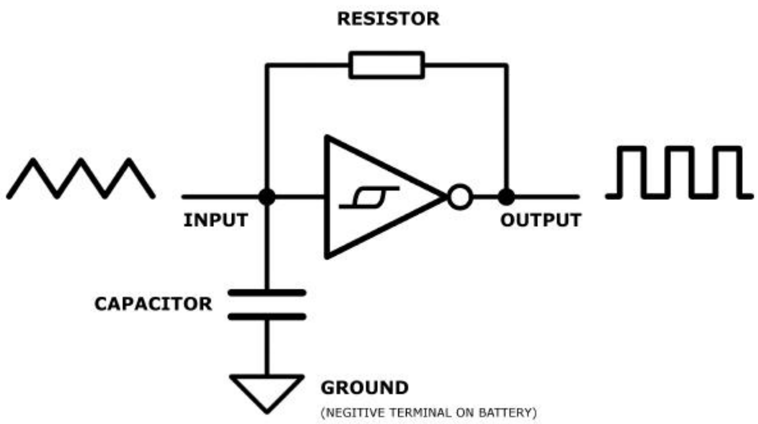
MAKE

Materials:

- 9 Volt Battery
- Battery Clip
- 40106 Chip
- Breadboard
- A selection of jumper wires
- A selection of electrolytic capacitors (100μF, 470μF, 1000μF)
- A selection of resistors (variable, 1K, 10K, 100K, 1M, Light Dependent Resistors)

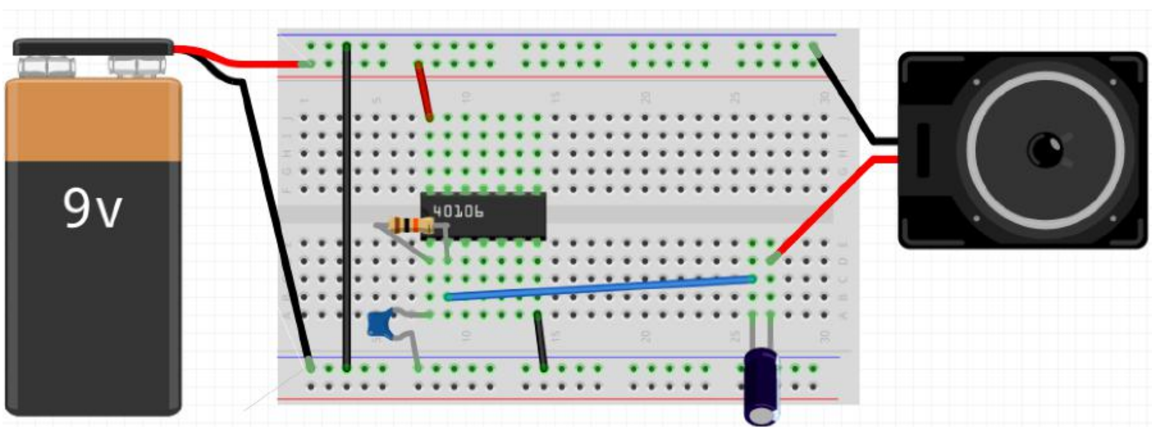


Schematic:



SCHMITT TRIGGER OSCILLATOR

Breadboard Layout:



Construction Notes:

Once you have built a number of oscillators, you can start connecting their inputs and outputs together in various combinations. Connect them together while the circuit is powered on and hooked up to your amp/speaker system. Connect the oscillators with different value resistors and capacitors. Experiment with the values and listen to how the sound changes. Be aware that the connections on a breadboard can be fiddly, and you need to make sure all of the connections are good.

How it Works:

Up to six analogue oscillators can be built with one 40106 chip. The frequency of each oscillator can be set individually. The oscillators can be Low Frequency Oscillators (LFOs - below 20hz). They can be Audio Frequency Oscillators (AFOs - 20 to 20,000hz). Or, they can be a frequency above the hearing range (HFOs - which can still influence the sound of the circuit, even if you can't hear the oscillator individually). After you have made a few connections between the oscillators, they start to influence and modulate each other depending upon their frequency. Complex sounds can quickly emerge from the network of interdependent oscillators.

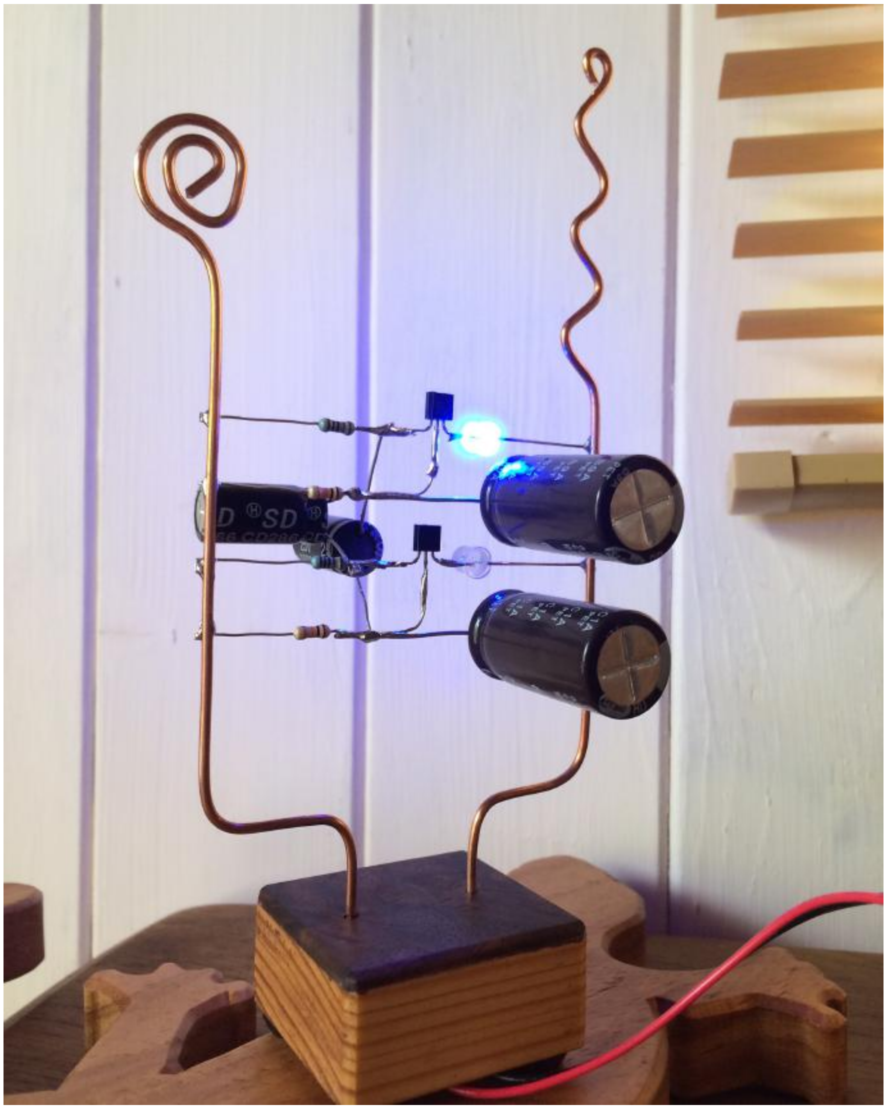
PLAY

Start with all six oscillators built but not connected to each other or the output. Perform by making various connections and swapping components live on the fly. Potentiometers, Light Dependent Resistors (LDRs) and various other control inputs can also be used to control the synthesiser.

EXPAND

Play with other instruments
Optical modulation – use of LDRs
Processing the sound with FX pedals or computer software

Freeform Circuits



TAGS

#Oscillation #Solder #Analogue #Sculpture #Craft #Installation #Discreet #Wire-wrapping #Wire #Transistor #Repetition #Generative #Process #Systems #Automated

BRIEF

Construct circuits without a traditional circuit board or enclosure. Components are connected together directly, or with pieces of solid wire that can be bent to form a structure. Individual oscillator modules can then be connected to form a larger structure that can produce complex sounds. These structures can be built as part of a performance, or they can be presented as an installation work. The freeform structures present a range of ideas connected to generative systems and automated music.

LISTEN

Rhytmic Sounds (1996) - Peter Vogel
Interactive Soundwall, 18 Photocells (LDRs)
https://www.youtube.com/watch?v=JisYOweWHLw

Discreet Music (1975) – Brian Eno

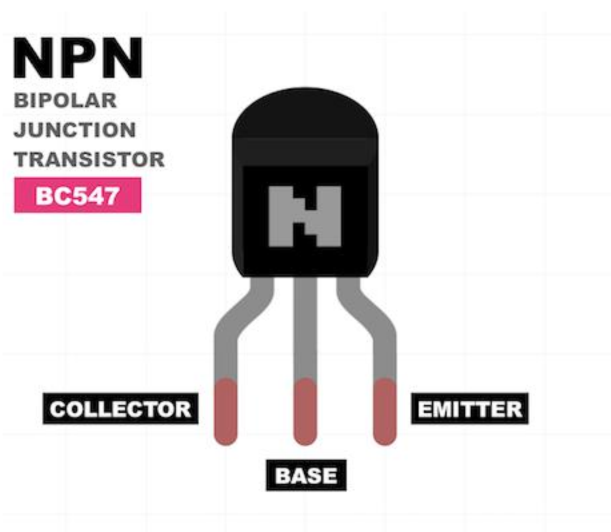
Pendulum Music (1968) – Steve Reich

MAKE

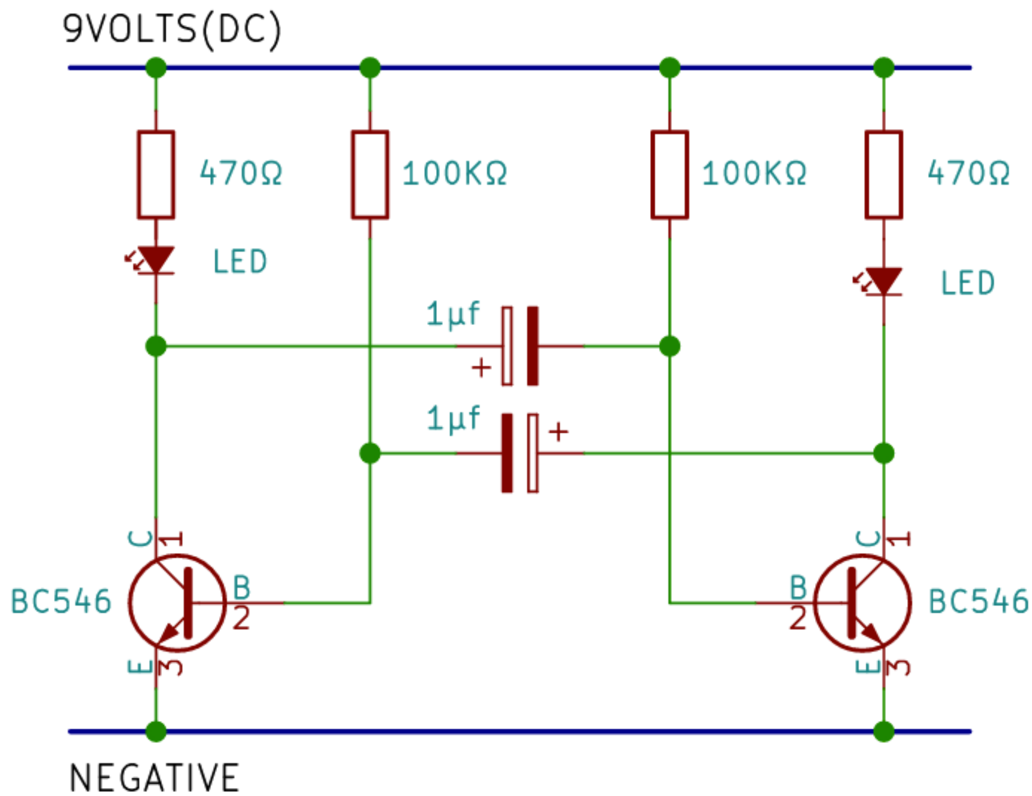
Materials:

- Solid copper wire (10 or 12 AWG)
- NPN transistors
- 9 Volt battery
- Crocodile clips
- A selection of ceramic capacitors (10nF, 100nF, 1μF)
- A selection of electrolytic capacitors (10μF, 100μF, 470μF, 1000μF)
- A selection of resistors (100Ω, 1K, 10K, 100K, 1M)

NPN Transistor:



Circuit Schematic:



Construction Notes:

It's best to start by building a simple circuit that uses discreet components (no chips). Use a helping hand device or some sticky tack to hold the parts in place while you solder them. Once you have built a module, crocodile clips can be used to connect power and the audio output for testing. Pliers are useful for shaping the solid wire and the legs of the components. To make an oversized circuit with jumbo-sized components, you can use components with a higher power rating. For example, you might want to use two-watt, rather than quarter-watt resistors.

How it Works:

You can try this technique with almost any circuit. The main limiting factor is the size of the components and how easy they are to handle and solder. Avoid tiny component packages and surface mount technology, unless you have tweezers and a lot of patience.

PLAY

Explore generative, process and systems music (automated music). How can a generative system be ‘played’?

EXPAND

Adding sensors so that the circuit can react to the environment
Mounting the circuit on wood
Casting the circuit in a block of resin

Sudophone

TAGS

#Touch #Gesture #Hand-held #Oscillation #Resonance #Continuum #Reductionist #Resistance #Tin can #Electroacoustic #Conductivity #Salvage #Mute

BRIEF

The Sudophone exemplifies a Dirty Electronics approach. It consists of a simple oscillator circuit using a 555 timer integrated circuit (IC), miniature loudspeaker, ‘junk’ tin can and grip-bolts. The Sudophone is played by holding the tin can and gripping its bolt. A hand can also cup the opening of the tin to produce a mute effect. Squeezing the bolt and tin alters the pitch of the instrument through using the conductivity of the human body to change the resistance of the circuit. Without touch there is no sound. With touch there is pitch, filtering and dynamic (muting) control. The instrument requires no amplification, the output from the 555 drives the loudspeaker directly, and is in the true sense ‘electroacoustic’.

LISTEN

The Sudophone is a cross between the Crackle Box of Michel Waisvisz and the miniature resonating objects found in the works of Alvin Lucier.

Chambers (1968) - Alvin Lucier

The Art of the Theremin by Clara Rockmore (1999) Clara Rockmore

In Tune CD (2005) - Michel Waisvisz

MAKE

The electronic circuit for the instrument can be put together in a number of different ways. The parts for the instrument are cheap, the battery being the most expensive item.

Instructions on making the Sudophone can be found in the appendices and at:
http://www.dirtyelectronics.org/docs/sudomini.zip

PLAY

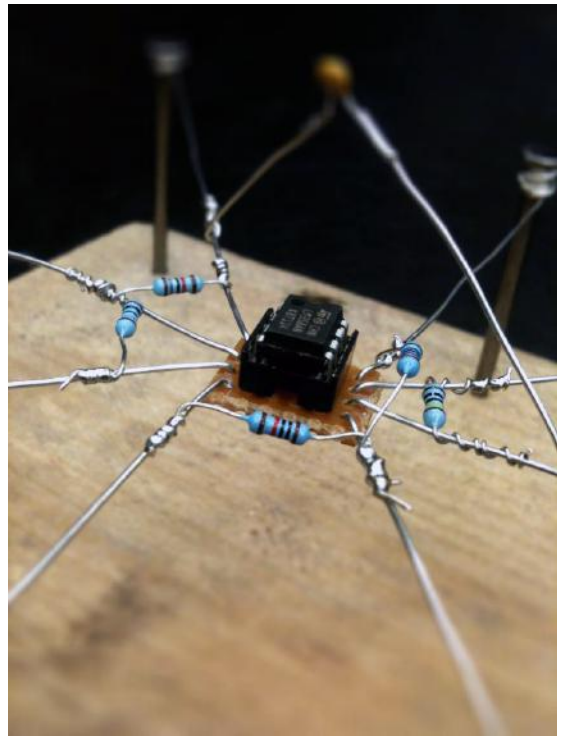
The Sudophone lends itself to a range of performance possibilities. The instrument has also served as a good pedagogic device and workshop primer to consider ways of re-engaging the body in performance and designing electronic instruments. The musician, having built the electronic instrument, has an understanding of the device that ultimately informs the performance: the musician becomes a superuser.

I Love You (2007) - ed. John Richards
Sudophonia (2009) - Pauline Oliveros
Conversing with Ducks (2009) - Howard Skempton
A-political Piece (2018) - Leigh Landy
The Chain (2008) - John Richards

EXPAND

The touch controls can be modified to incorporate other objects and conductive materials. The current can also be passed through multiple users/performers' bodies to control the instrument: for example, John Richards' *The Chain* (2008).

Bed of Nails

TAGS

#Touch #Gesture #Oscillation #Feedback #Noise #Breadboard #Wire-wrapping #Prototypic #Conductivity #Amplifier #Schematic #Solderless #Crocodile clip #Crackle Box

BRIEF

The Bed of Nails explores freeform and prototypic methods of construction for electronic circuits. Breadboard is the name given to prototyping environments in electronics. It derives from early electronic engineers and amateurs banging nails into wood (breadboards) and using wire-wrapping, solderless techniques to construct prototypes. This method represents a pedagogic tool for the reading of electronics schematics and the building of circuits. The Bed of Nails is made from mixed materials - wood, nails, wire, electronic components – and using of a range of tools.

The Bed of Nails is built around ideas of amplifier feedback, open ‘clip art’ circuitry, and touch and conductivity of the body. The instrument produces a range of pitched and non-pitched (noise-based) sounds, and raises issues of the human body in performance and instrumental control due to the unstable, fluctuating nature of skin resistance.

LISTEN

Oliveros, Pauline, *No mo*, Chester, NY: Pogus Productions, c. 2001.

Nakamura, Toshimaru. No-input Mixing Board. Zero Gravity, ZGV-026, 2000.

Network 2 (2018) - Luigi Marino

MAKE

Extension wires are soldered to the eight pins of the integrated circuit (IC) (dual op amp) and wrapped around a nail: each nail represents an IC pin.

The nails are used to 'physicalise' the schematic: a physical representation of the circuit.

Instructions on making the Bed of Nails can be found in the appendices and at: http://dirtyelectronics.org/docs/Bed_of_Nails.zip

PLAY

Hidden Sine (2015) - John Richards

EXPAND

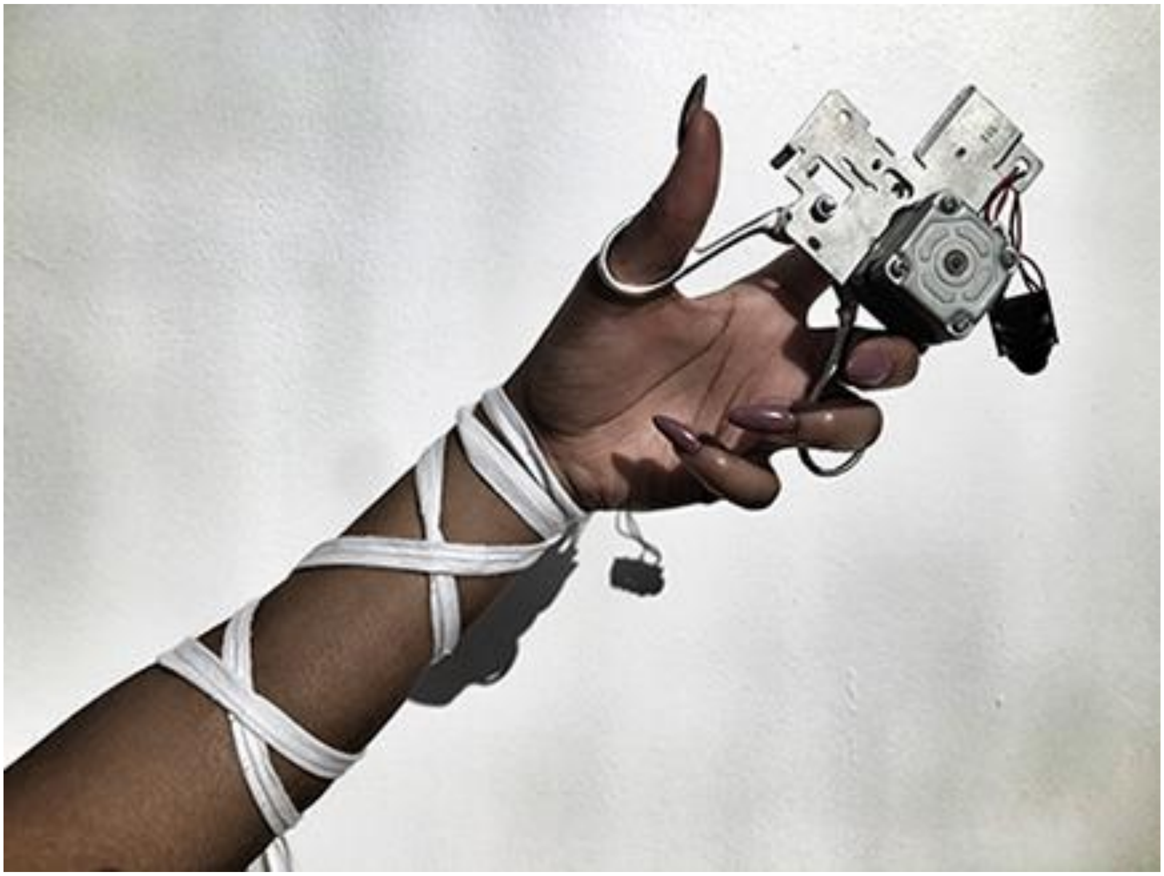
The touch controls can be modified to incorporate other objects and conductive materials. The current can also be passed through multiple users/performers' bodies to control the instrument.

Input signals can be passed through the Bed of Nails. The Bed of Nails makes and excellent distortion circuit and pre-amp. Connect an input signal to nail 3 (or 2) and the ground, nail 4.

Use a signal to modulate the sound of the Bed of Nails. Example, *Hidden Sine* (2015) where an old computer hard drive is connected to the Bed of Nails.

The Bed of Nails may be also turned into a coloured noise generator with a minor modification and addition of a resistor. See Noise and Nails circuit.

Motor Music



TAGS

#Motor #Machine #Gesture #Current #Waveform #Hand #Kinetic energy #Bowing #Appropriation #Salvage #Glitch #Found sound #Rectifier

BRIEF

For salvaged motors that become hand-cranked synthesisers and noisemakers. What happens when an AC or DC motor is plugged raw into a mixing desk or connected directly to a speaker?

Motor Music explores 'low level' instrument design. The project also sets up a proposition concerning electronic music: 'How can it be done simpler?' The motor as 'instrument' encourages an objection-orientated approach to sound and music making: the motor itself has inherent musical qualities and potential that needs to be 'found'. The turning of the motor shaft also presents ideas surrounding gesture and human, machine interaction.

LISTEN

Oval. 1994. *Systemisch.* Frankfurt: Mille Plateaux MPCD9

Motor Music (2012) - John Richards

Yasunao Tone. 1997. *Solo for Wounded CD*. Tzadik TZ 7212

MAKE

Motors come in many different shapes and sizes: Direct Current (DC), Alternating Current (AC), brushless, stepper, etc.

Salvage a motor: old printers, scanners, CD players etc., contain motors.

Connect a jack socket to the terminals of a motor. Amplify the motor – connect to an amp/speaker.

When the motor is turned, electric current and a waveform is produced.

If the motor has more than two terminals (connections) – multiphase (for example, brushless motors) – experiment with combination of connections to produce different outputs/waveforms.

NOTE: Very low frequencies and DC can be produced. Take care when amplifying.

PLAY

The music is ‘found’ in the motors.

EXPAND

Think about different gestures associated with turning motors. Try attaching levers, pulleys or handles to the motors. See examples, such as the “scissor synth” pictured above and Richards’ *Ribbon & Strings* (2013), where ribbons are used to ‘bow’ the motors.

Ribbon & Strings (2013) - John Richards
https://vimeo.com/72521124

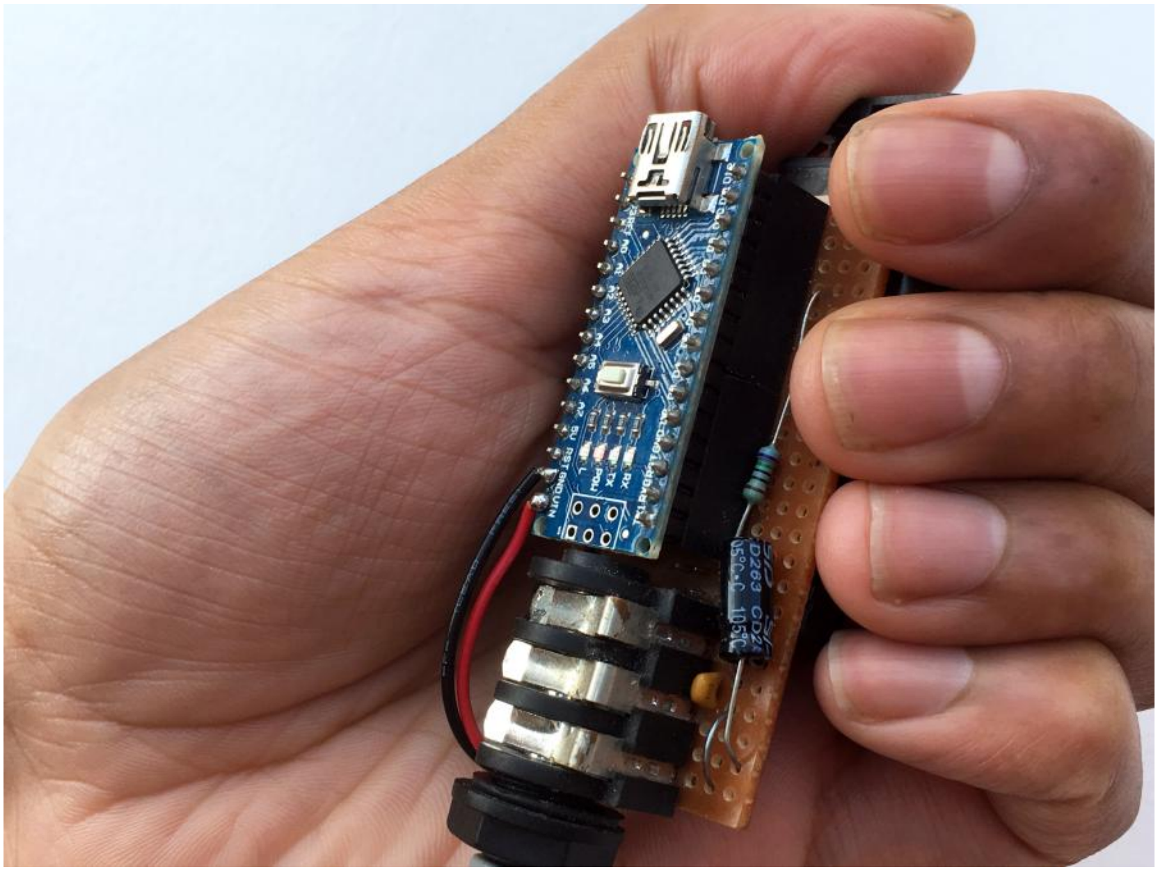
Use the motors to generate current.

Make a bridge rectifier to covert alternating current (AC) to direct current (DC) to power a synthesiser or sound circuit.

Add capacitors to smooth the voltage and create long sustained sounds.
http://dirtyelectronics.org/docs/charge_doc.zip

Example:
Charge/Discharge (2012) - John Richards
https://vimeo.com/178093813

Electric Shaker



TAGS

#Code #Arduino #Hand #Gesture #Shaker #Percussive #Noise #Digital #Random #Seed #Programmable #Indeterminacy #Tilt switch #Wavetable #Embedded electronics

BRIEF

The electric shaker is a digital synthesiser that is controlled by shaking two tilt switches backwards and forwards. Sounds can be sustained by keeping the shaker orientated horizontally. It uses a microprocessor and digital wavetable synthesis to create sound, and it is capable of producing noise, tones and complex timbres. When you switch on the instrument, the time-interval between the on switch and the first shake is measured and stored. This interval is used to set the timbre of the sound, and once the sound is set, it remains that way until the instrument is reset. This means that the instrument sounds different each time you switch it on.

LISTEN

Music of Changes (1951) - John Cage

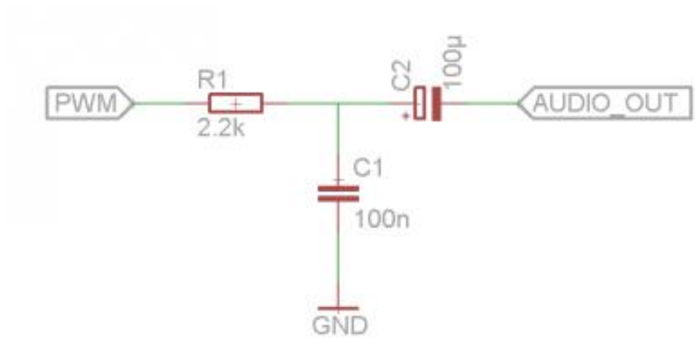
1-Bit Symphony (2010) - Tristan Perich
http://www.1bitsymphony.com/

The Hands (Movement 1) (1987) - Michel Waisvisz

MAKE

Two tilt switches are connected to the Arduino's input pins and orientated in opposite directions. A RC (resistor, capacitor) filter is also used to smooth out the audio coming from the Arduino: a very basic digital to analogue convertor.

Audio Output Filter:



Code:

```
byte skip = 1; // Sample skipper
byte inc = 0; // Wavetable increment
byte state = 0; // Initial state flag
byte volume = 0; // Audio volume for amplitude envelope

byte SINE[] =
{128,131,134,137,140,143,146,149,152,155,158,162,165,167,170,173,176,179,1
82,185,188,190,193,196,198,201,203,206,208,211,213,215,218,220,222,224,22
6,228,230,232,234,235,237,238,240,241,243,244,245,246,248,249,250,250,251,
252,253,253,254,254,254,255,255,255,255,255,255,255,254,254,254,253,253,2
52,251,250,250,249,248,246,245,244,243,241,240,238,237,235,234,232,230,22
8,226,224,222,220,218,215,213,211,208,206,203,201,198,196,193,190,188,185,
182,179,176,173,170,167,165,162,158,155,152,149,146,143,140,137,134,131,1
28,124,121,118,115,112,109,106,103,100,97,93,90,88,85,82,79,76,73,70,67,65,
62,59,57,54,52,49,47,44,42,40,37,35,33,31,29,27,25,23,21,20,18,17,15,14,12,11
```

```
,10,9,7,6,5,5,4,3,2,2,1,1,1,0,0,0,0,0,0,0,1,1,1,2,2,3,4,5,5,6,7,9,10,11,12,14,15,17,
18,20,21,23,25,27,29,31,33,35,37,40,42,44,47,49,52,54,57,59,62,65,67,70,73,76
,79,82,85,88,90,93,97,100,103,106,109,112,115,118,121,124};

void setup()
{
 pinMode(2, INPUT_PULLUP); // tilt switch 1
 pinMode(3, INPUT_PULLUP); // tilt switch 2
 pinMode(9, OUTPUT); // audio output

 TCCR1B = TCCR1B & B11111000 | B00000001; // Setup fast PWM mode
}

void loop()
{
  if(digitalRead(2) == 0)
  {
   if(state == 0)
   {
    randomSeed(millis());
    skip = random(255) + 1;
    state = 1;
   }

   if(volume < 255){ volume++; }
   analogWrite(9, SINE[inc] * volume / 255);
   inc = inc + skip;
  }

  if(digitalRead(3) == 0)
  {
   if(state == 0)
   {
    randomSeed(millis());
    skip = random(255) + 1;
    state = 1;
   }

   if(volume < 255){ volume++; }
   analogWrite(9, SINE[inc] * volume / 255);
   inc = inc + skip;
  }

  if(digitalRead(2) == 1 && digitalRead(3) == 1)
  {
   if(volume > 0){ volume--; }
```

```
    analogWrite(9, SINE[inc] * volume / 255);
    inc = inc + skip;
  }
```

PLAY

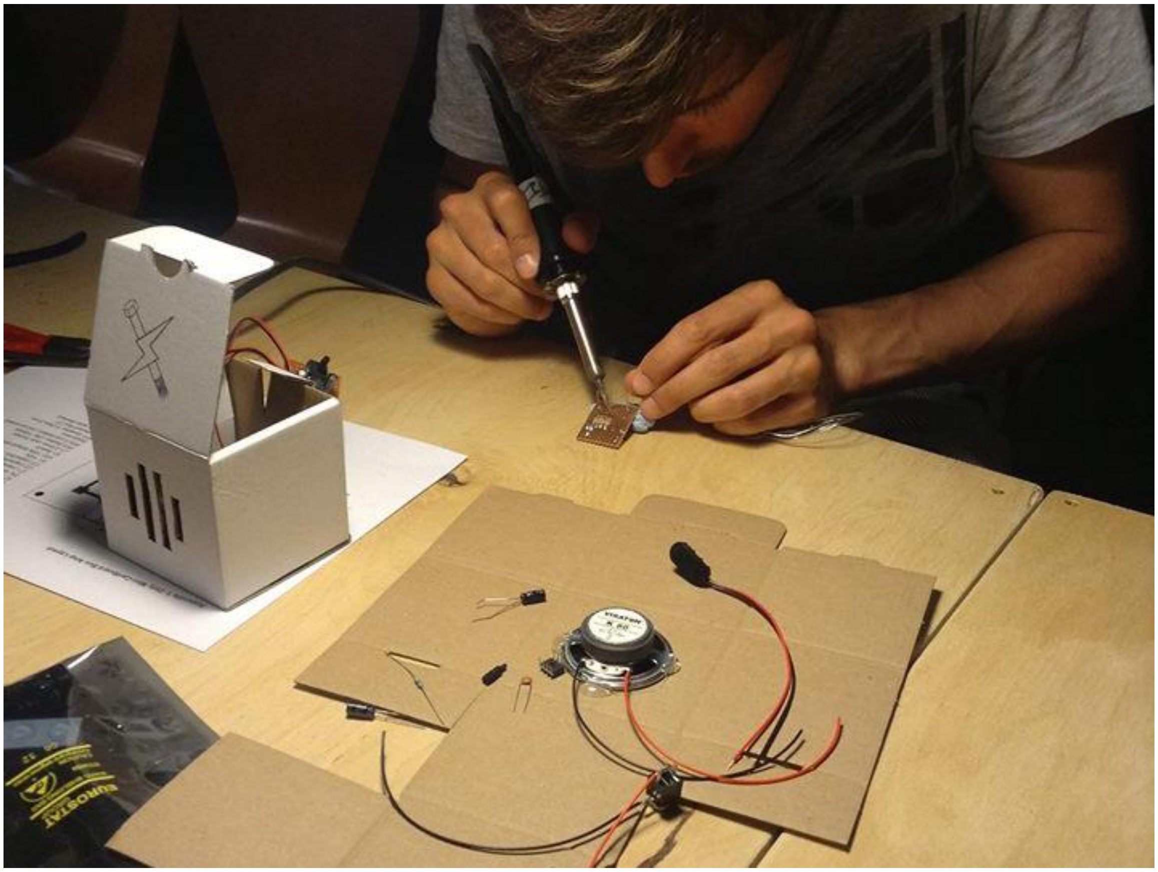
Pulse Hocket Drone (2018) - Duncan Chapman

EXPAND

To create more complex sounds a synthesis library such as Mozzi can be used:
http://sensorium.github.io/Mozzi/

An accelerometer may be used instead of tilt switches

Cardboard Box Amp



TAGS

#Amp #Speaker #Portable #Battery-powered #Gesture #Movement #Space #Environment #Sound diffusion #Doppler effect

BRIEF

The Cardboard Box Amp is an economic portable battery-powered amp, with volume control, on/off switch, jack socket input and strap bolts. It has a full-range four-inch speaker and LM384 5W audio power amplifier housed in a five inch cubed box. The amp uses 2 x 9v (PP3) batteries.

As well as being a great little amp to amplify electronic sound sources, the amp and speaker can also be thought of as an instrument in its own right. Using a simple sound source, the portability of the amp offers possibilities to explore electronic sound, space and environment. Spinning and swinging speakers also produce a range of effects, for example, Doppler.

LISTEN

Speaker Swinging (1982) - Gordon Monahan
https://www.youtube.com/watch?v=delDUry0_eo

Bandoneonbook (2004) – Hans W. Koch
https://www.youtube.com/watch?v=s9c6OE1Ojq4

Hug/Laban (2013) - John Richards
https://vimeo.com/76315119

MAKE

Instructions on making the Cardboard Box Amp can be found in the appendices and at: http://www.dirtyelectronics.org/docs/DE_amp.zip

PLAY

Find a sound source and amplify. The hand, body or objects may be placed over the speaker to ‘play’ the instrument. Different resonances and ‘manual’ filtering/muting can be produced. Swing the speaker and amp.

Hug (2011) - John Richards
https://vimeo.com/55608667

De-controlled Amplifiers - Max Wainwright
http://www.maxwainwright.com/wiki/index.php?title=De-controlled_amplifiers

EXPAND

Different size speakers and boxes may be used
Customise the speaker grill (cut holes in the cardboard box for sound to omit)
Paint and decorate the boxes

Further Reading

Anderton, C. (1980) *Electronic Projects for Musicians*. New York: AMSCO.

Phil, A. (2007). Clip Art. *Leonardo Music Journal*, 17, 29-30.

Brindley, K. (2005) *Starting Electronics*. Amsterdam: Elsevier/Newnes.

Bowers, J. and Archer, P. (2005) Not Hyper, Not Meta, Not Cyber but Infra-Instruments. *Proceedings of NIME 05*, Vancouver, BC, Canada, 2005, 5-10.

Cascone, K. (2000) The Aesthetics of Failure: 'Post-Digital' Tendencies in Contemporary Computer Music. *Computer Music Journal* 24, 3, 12-18.

Collins, N. (2004) Composers Inside Electronics: Music after David Tudor. *Leonardo Music Journal*, 14, 1-3.

Collins, N. (2006) *Handmade Electronic Music: The Art of Hardware Hacking*. New York: Routledge.

Davies, H. (2002) *Sounds Heard*. Chelmsford: Soundworld Publishers.

Ghazala, R. Q. (2005) *Circuit-Bending: Build Your Own Alien Instruments*. Indianapolis: Wiley Publishing, Inc.

Ghazala, R. Q. (2004) The Folk Music of Chance Electronics: Circuit-Bending the Modern Coconut. *Leonardo Music Journal*, 14, 96-104.

Lancaster, D. (1977) *CMOS Cookbook*. Indianapolis: H.W. Sams

Richards, J. (2008) Getting the Hands Dirty. *Leonardo Music Journal*, 18.

Richards, J. (2013) Beyond DIY in Electronic Music. *Organised Sound*, vol. 18, no. 3, 274–281.

Richards, J. (2017) DIY and Maker Communities in Electronic Music. *The Cambridge Companion to Electronic Music*, 238-257.

Stevens, J., Doyle, J., & Crooke, O. (2007). *Search & Reflect: A Music Workshop Handbook* (2nd ed.). Teddington: Rock School.

LISTEN

MUSIC OF OBJECTS

1. Electro-cricket
#Oscillation #Resonance #Percussive #Rhythmic #Repetition #Phasing #Electromechanical #Solderless #Analogue #Relay #Capacitor #Crocodile clip #Prototypic

Clapping Music (1972) - Steve Reich

Opera with Objects (1997) - Alvin Lucier

Rainforest (1968) - David Tudor
https://www.youtube.com/watch?v=vj1WTsEPcG0

2. Guinea Pig
#Amplification #Resonance #Acoustic #Electro-acoustic #Gesture #Object #Percussion #Microphone as instrument #Found sound

Variations II (1961) - John Cage

Sharon Gal's Happening (2007) - Adam Bohman
https://www.youtube.com/watch?v=CKvCxaixheY

Mixtur (1964) - Karlheinz Stockhausen

KCRW Radio, Episode 44: Contact Milk - Produced by Lawrence Dunn.
https://www.kcrw.com/news-culture/shows/the-organist/episode-44-contact-milk

MUSIC OF THINGS

3. Live Breadboarding
#Breadboard #Prototypic #Oscillation #Modulation #Synthesizer #Solderless #Analogue #Patching #Liveness #Live #Performance

Loud Objects live at Bent Festival in New York (2007) -
https://www.youtube.com/watch?v=U1TZ0gMGmVU
http://www.loudobjects.com/

Breadboard band
http://www.breadboardband.org

Live coding
https://slab.org

4. Freeform Circuits
#Oscillation #Solder #Analogue #Sculpture #Craft #Installation #Discreet #Wire-

wrapping #Wire #Transistor #Repetition #Generative #Process #Systems #Automated

Rhytmic Sounds (1996) - Peter Vogel
Interactive Soundwall, 18 Photocells (LDRs)
https://www.youtube.com/watch?v=JisYOweWHLw

Discreet Music (1975) – Brian Eno

Pendulum Music (1968) – Steve Reich

MUSIC OF TOUCH

5. Sudophone

#Touch #Gesture #Hand-held #Oscillation #Resonance #Continuum #Reductionist #Resistance #Tin can #Electroacoustic #Conductivity #Salvage #Mute

Chambers (1968) - Alvin Lucier

The Art of the Theremin by Clara Rockmore (1999) Clara Rockmore

In Tune CD (2005) - Michel Waisvisz

6. Bed of Nails

#Touch #Gesture #Oscillation #Feedback #Noise #Breadboard #Wire-wrapping #Prototypic #Conductivity #Amplifier #Schematic #Solderless #Crocodile clip #Crackle Box

Oliveros, Pauline, *No mo*, Chester, NY: Pogus Productions, c. 2001.

Nakamura, Toshimaru. No-input Mixing Board. Zero Gravity, ZGV-026, 2000.

Network 2 (2018) - Luigi Marino

MUSIC OF ACTIONS

7. Motor Music

#Motor #Machine #Gesture #Current #Waveform #Hand #Kinetic energy #Bowing #Appropriation #Salvage #Glitch #Found sound #Rectifier

Oval. 1994. *Systemisch.* Frankfurt: Mille Plateaux MPCD9

Motor Music (2012) - John Richards

Yasunao Tone. 1997. *Solo for Wounded CD*. Tzadik TZ 7212

8. Electric Shaker
#Code #Arduino #Hand #Gesture #Shaker #Percussive #Noise #Digital #Random #Seed #Programmable #Indeterminacy #Tilt switch #Wavetable #Embedded electronics

Music of Changes (1951) - John Cage

1-Bit Symphony (2010) - Tristan Perich

The Hands (Movement 1) (1987) - Michel Waisvisz

MUSIC OF SPACE

9. Cardboard Box Amp
#Amp #Speaker #Portable #Battery-powered #Gesture #Movement #Space #Environment #Sound diffusion #Doppler effect

Speaker Swinging (1982) - Gordon Monahan
https://www.youtube.com/watch?v=delDUry0_eo

Bandoneonbook (2004) – Hans W. Koch
https://www.youtube.com/watch?v=s9c6OE1Ojq4

Hug/Laban (2013) - John Richards
https://vimeo.com/76315119

Scores (published separately)

Sudophone I
I Love You - John Richards
Conversing with Ducks - Howard Skempton

Amplification and space
De-controlled amp - Max Wainwright
Hug - John Richards

Freeform and prototypic
Five Dreams - Duncan Chapman
Live Breadboarding - Jim Frize

Objects and contact mics
Katydid Phase - Jim Frize
Guinea Pig - John Richards

Sudophone II
Sudophonia - Pauline Oliveros
New Work - Makoto Nomura

Generators and motors
Charge/Discharge - John Richards
Motor Music - John Richards

Code
Pulse Hocket Drone - Duncan Chapman
Snöstorm - Jim Frize

Sudophone III
A-political Piece - Leigh Landy
The Chain - John Richards