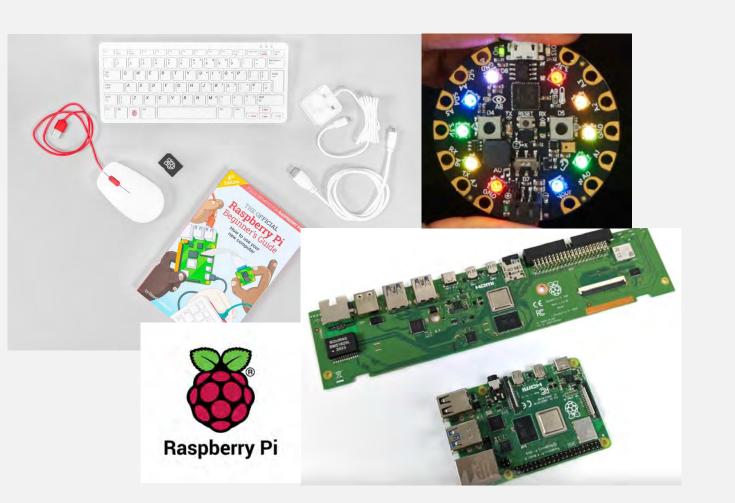


PLAY WITH CIRCUIT-BENDING

electronics introduction: interactive hardware tweaking



TTU Makerspace

. . .

Raspberry Pi 400/CPX

+

Electronic toys

2025

Sean W Scully

Lead Administrator - TTU Libraries - Emerging Technology

Rhino3D, TinkerCAD, AutoCAD Inventor, Fusion360, Blender, Solidworks MakeCode, Python, Scratch, C++, C, MATLAB, JS, Assembly, Verilog, Xilinx

General Studies BS - Math/Engineering/Renewable Energy, TTU

MFA, Studio Art - Metals/Jewelry/Enameling, Kent State Univ

BFA, Studio Art - Metalsmithing/Jewelry Design, TTU

AA, Fine Arts, South Plains College

linkedin.com/in/seanwscully

Find me on the First Friday Art Trail, ffat.org, CASP Work Studio H







Emerging Technology

- Makerspace: Main Library, 2nd floor, room 210
- VR Lab: Main Library, 2nd floor, room 201A

make@ttu.edu

https://www.depts.ttu.edu/library/make/

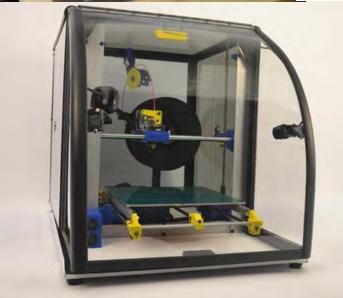








Cricut | Maker



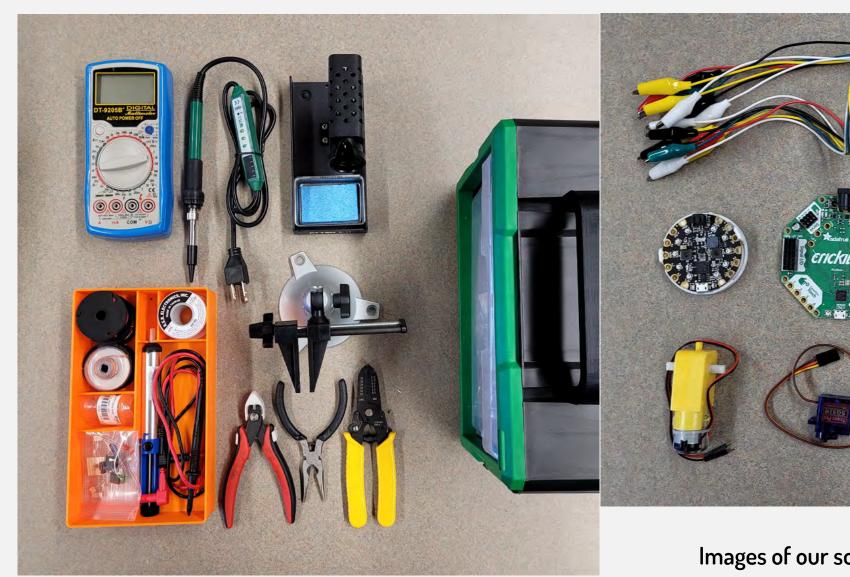


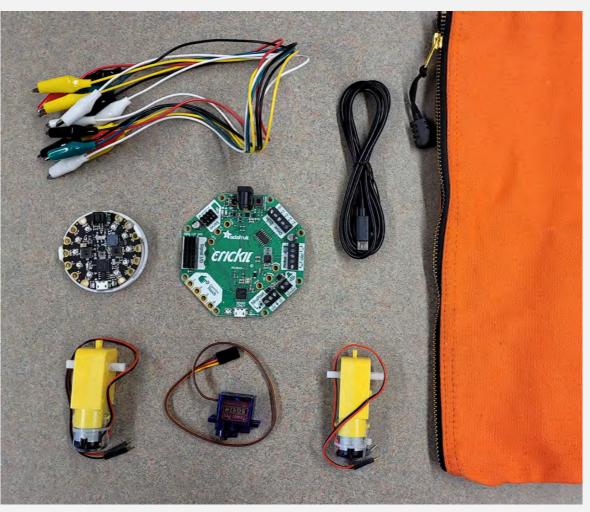


- Cricut Maker/Venture
- Glowforge Lasercutter
- Makyu Formbox
- Matter&Form 3D Scanner
- PolyPrinters 229 & 508
- Ultimaker 3, S7
- Sewing machines



TTU Library's Makerspace *Electro* and *Robo* Kits

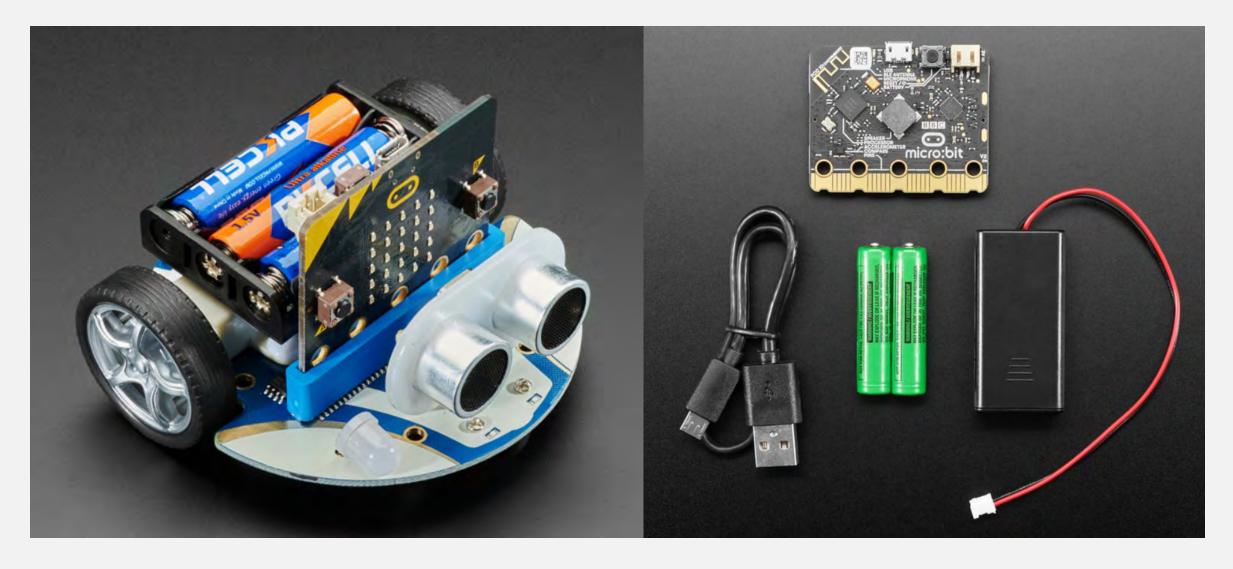




Images of our soldering kit and cpx/crickit kit



TTU Library's Makerspace CuteBot and Micro:Bit v2 Kits



Images of our CuteBot kit and Micro:Bit v2 kit



TTU Library's Makerspace *Pi-400* and *Pi-ZeroW* Kits





6 kits of each is available: recommend supplying your own microSD card (minimum size: 8Gb)



TTU Library's Makerspace *Pi-500* and *Pi-Zero2W* Kits



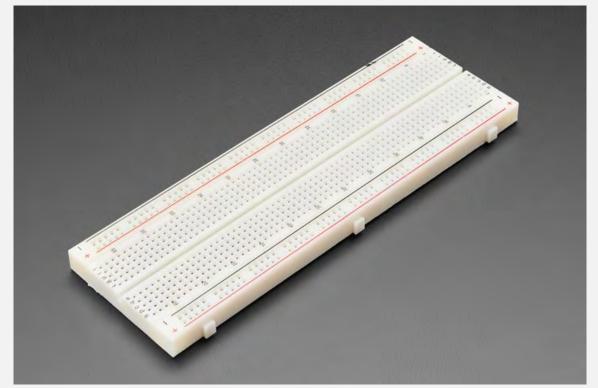


2 kits of each is available: recommend supplying your own microSD card (minimum size: 32Gb)



TTU Library's Makerspace *Pi – Interface* Kits





6 kits of each is available, one for every Pi-400

- Pi T-Cobbler Plus
 - GPIO Breakout Pi A+, B+, Pi 2/3/4, Zero
- Full Sized Premium Breadboard
 - 830 Tie Points



TTU Library's Makerspace iFixit Kits























6 kits of each is available, one for every Pi-400

- all kinds of screwdriver tips, 64 total
- larger kit has spudgers and plastic pryers

what is Circuit-Bending?

- art of creatively modifying the circuits of electronic devices, such as children's toys
- produces unexpected and innovative sounds

why Circuit-Bend?

- allows us to creatively transform ordinary toys into unique musical instruments
- promotes experimentation and exploration in the world of electronics



Circuit-Bending philosophy

- realm of electronics
 - experimentation
 - curiosity
 - play

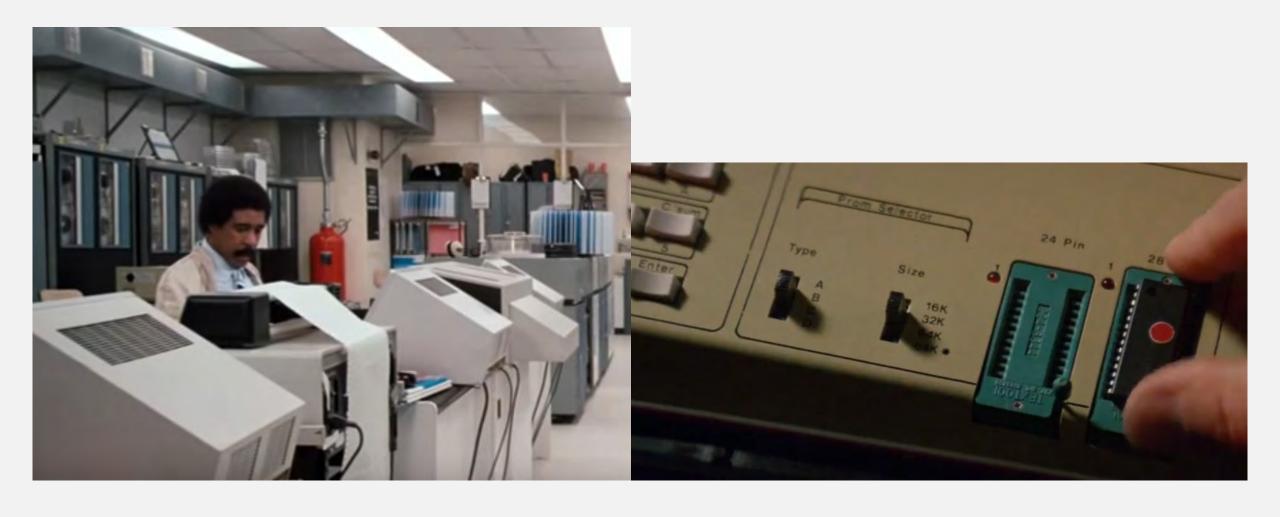


- repurposing / modifying existing device
 - challenge traditional notions of technology/creativity,
 - fostering a spirit of innovation/discovery
- intersection of art/technology/DIY ethos



computing – eras, 1980s

• Superman 3 (1983) VS Real Genius (1985)





robots - eras, 1980s-2000s

• *Johnny5* (1986-8) VS BEAM robotics (1988-2002)



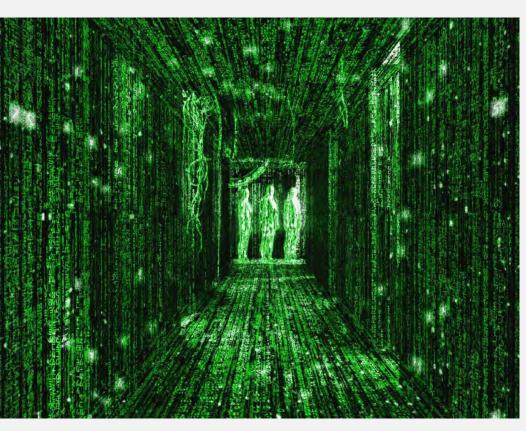




computing – eras, 1990s-2000s

• Hackers (1995) VS The Matrix (1999)





F

computing - eras, 2010s

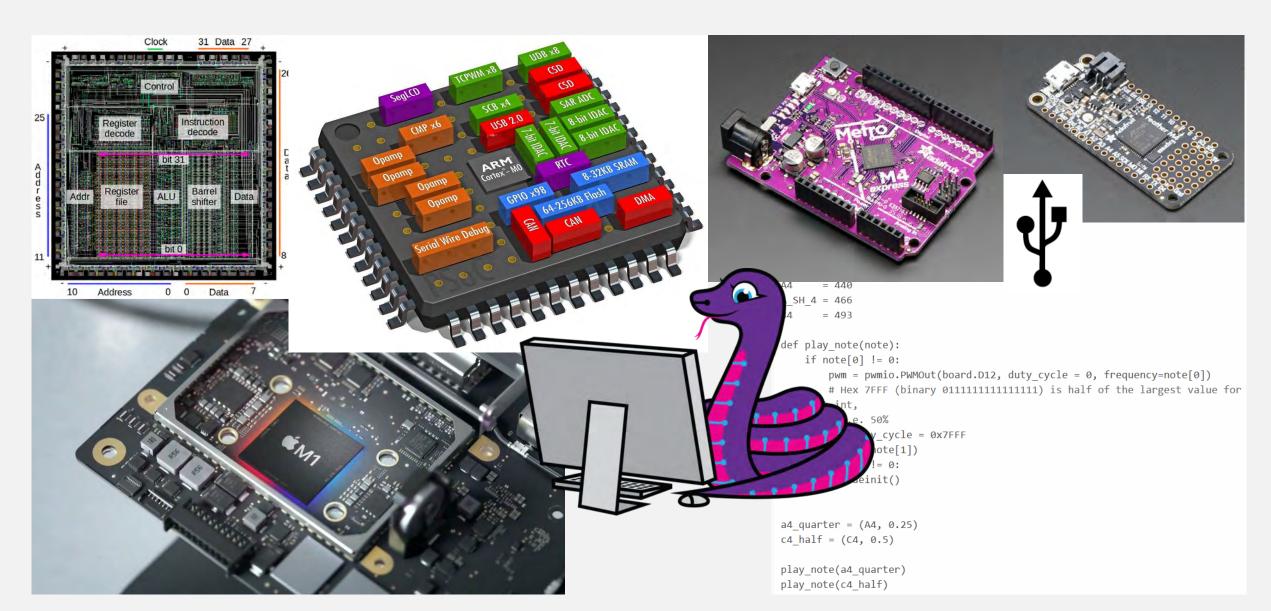
• CHAPPIE (2015) VS CircuitPython + ARM chips (2017)





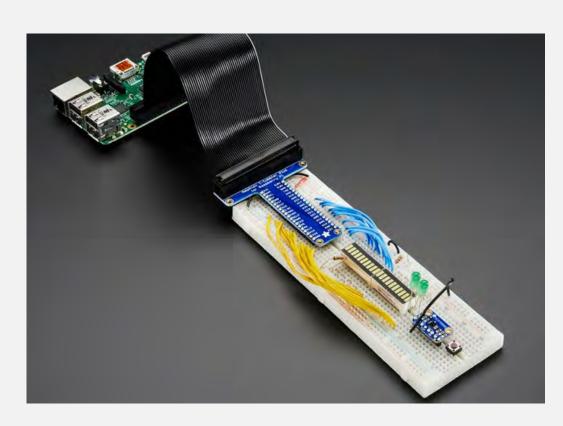
Hardware differences - Structure, Purpose

Python - multi-core microprocessors and ARM processors (2010's) - microcontrollers programmable by USB

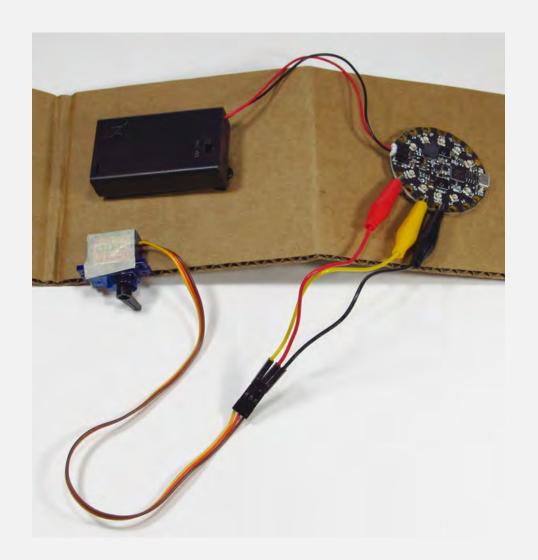




TTU Library's Makerspace Pi 400 or CPX interface



- Pi T-Cobbler Plus {above}
 - GPIO Breakout Pi A+, B+, Pi 2/3/4, Zero
- Circuit Playground Express (CPX) {right}
 - Alligator clip interface for voltage/signal



safety first

- unplugging the Toy
 - before starting any circuit-bending techniques, always unplug the toy from its power source to avoid electrical shock.
 - double-check that the toy is completely disconnected from power before proceeding.
- handling Electrical Components
 - when working with exposed circuit boards, be cautious around electrical components such as resistors, capacitors, and integrated circuits
 - avoid touching these components with bare hands or conductive items, as they may carry a charge or become damaged.
- proper Tools and Gear
 - use appropriate tools, such as screwdrivers, pliers, and wire cutters, to open and manipulate the toy's circuit board.
 - wear safety goggles and insulating gloves when handling electrical components to protect yourself from potential hazards.
- by following these safety guidelines, you can enjoy a safe and productive circuit-bending experience.
- remember, safety first!

blue smoke alert

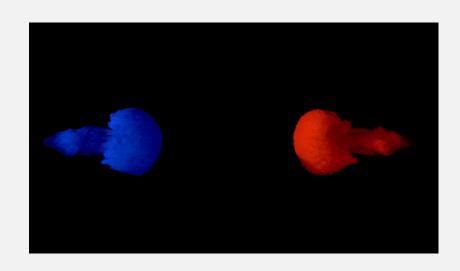
- 3.3 5V max
- tips to avoid damaging the toys:

• start small:

- begin by making small modifications to the circuit board
- test the effects before making more significant changes
- understand the impact of each alteration
- avoid causing irreversible damage to the toy

document and label:

- track the modifications you make by documenting the changes
- label different components on the circuit board
- helps you troubleshoot any issues that may arise
- prevents accidentally undoing previous successful modifications



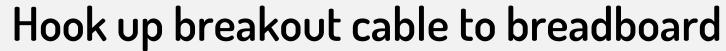


let's get started - version 1

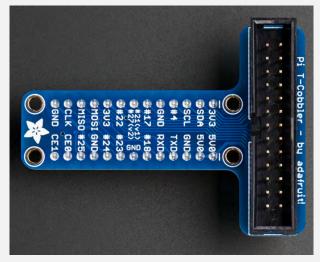
setup Raspberry Pi 400

- Pi 400 Tour/Teardown
- flash a microSD card links & flasher program
- cords & startup

Open the toy! multimeter time



 Pull power from breadboard to use in toy play!







let's get started - version 2

setup Circuit Playground Express

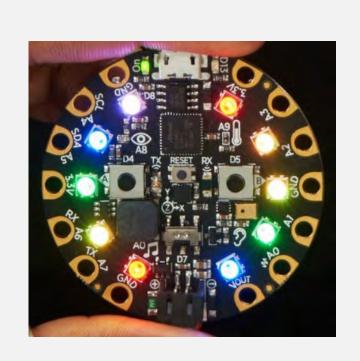
- CPX Tour
- Alligator clips & USB power

Open the toy!

multimeter time

Hook up alligator clips to CPX

• pull power from CPX to use in toy play!



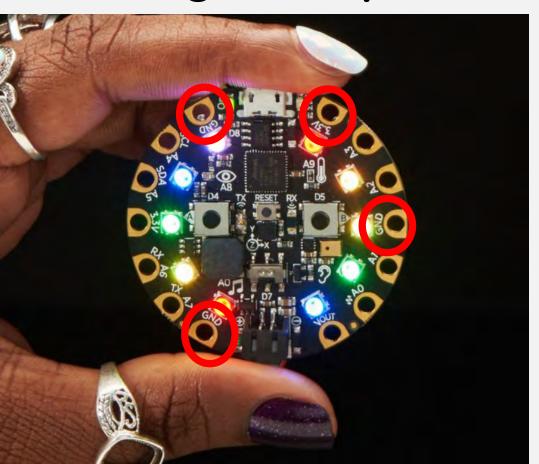


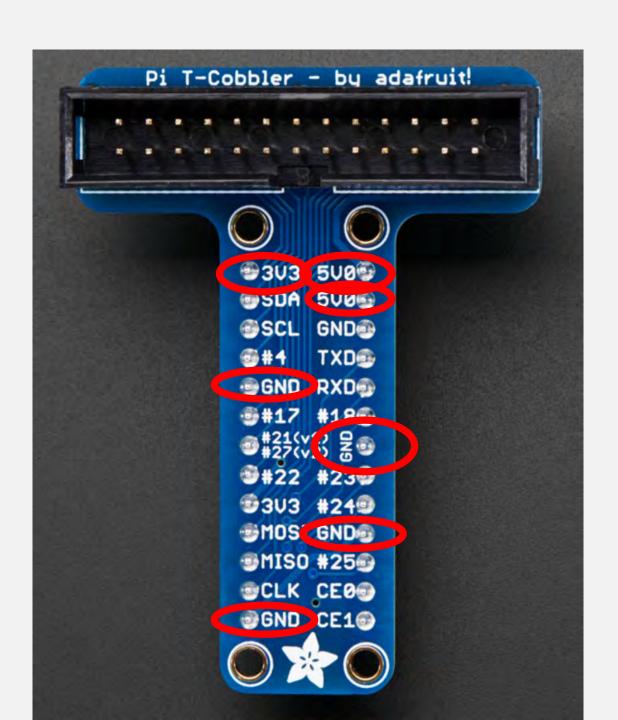
Circuit Playground Express

•

Alligator Clips

VS.







components – 1/3

let's dive into the circuit board of your chosen toy - get ready to discover!

- Resistors:
 - regulate the flow of electrical current in a circuit.
 - changing the resistance value of a resistor, you can alter the pitch or volume of the sounds produced by the toy
- Capacitors:
 - store and release electrical energy in a circuit.
 - modifying the capacitance value of a capacitor can create delay effects, add resonance, or introduce interesting glitches to the toy's sounds
- Integrated Circuits (ICs):
 - the brain of the toy, controlling its functions and sound generation.
 - experimenting with different ICs or modifying their connections can drastically change the toy's behavior and create new sound patterns

components – 2/3

Switches:

- allows you to introduce on/off controls or trigger special effects in real-time
- switches can be used to modulate sound parameters, create loops, or activate hidden features in the toy

Potentiometers:

- also known as pots, are variable resistors that allow you to manually adjust parameters like pitch, frequency, or modulation speed in real-time.
- adding potentiometers to the circuit, you can create interactive and customizable sound controls

• Diodes:

- control the direction of electrical current flow in a circuit.
- adding diodes in strategic locations, you can create unique distortion effects, clipping sounds, or feedback loops in the toy's output

components – 3/3

• Transistors:

- amplify or switch electronic signals in a circuit
- modifying the transistor configuration or biasing can produce overdrive effects, envelope shaping, or voltage-controlled modulation in the toy's sound output

• LEDs:

- Light Emitting Diodes (LEDs) are not only visual indicators but also interactive components in circuit-bending
- by connecting LEDs to the circuit, you can create visual feedback or use them as triggers for sound modulation effects in real-time

Speaker Modifications:

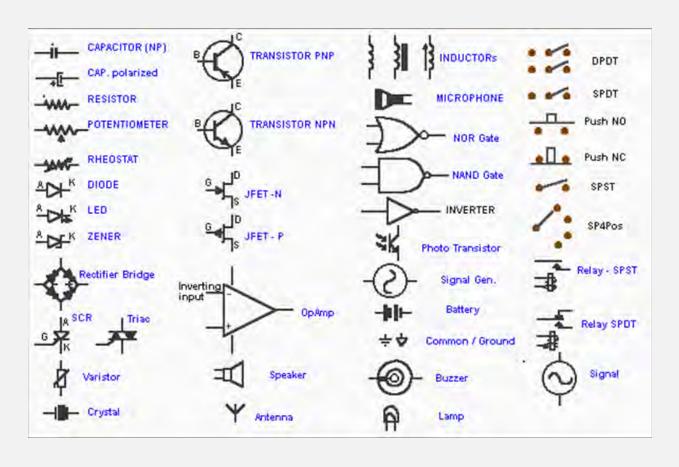
- experimenting with connections, impedance, or placement can dramatically alter the toy's sound output.
- try adding external speakers, changing the speaker's polarity, or using the speaker as a microphone for unconventional sound manipulations

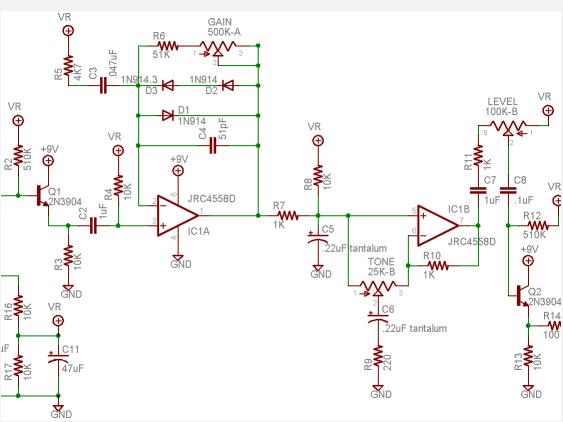
electronics tutorials

- Collin's Lab playlist of simple shorts on how various components and processes work.
 - https://www.youtube.com/watch?v=KoSatCnclhE&list=PLjF7R1fz_00U08_hRcayfVZSmTpBCGJbL
- Adafruit's Circuit Playground playlist of Alphabet-based videos on how electronics work aimed at kids
 - https://www.youtube.com/watch?v=k5Sf0GwWBEs&list=PLjF7R1fz_00XWHQhEVEI5Jqf18TQRr5Hu
- Handmade electronic music: the art of hardware hacking (important text in circuit-bending):
 - https://www.nicolascollins.com/handmade.htm
- tim hunkin Secret Life of Machines remastered & a brand new series!
 - https://www.youtube.com/@timhunkin1



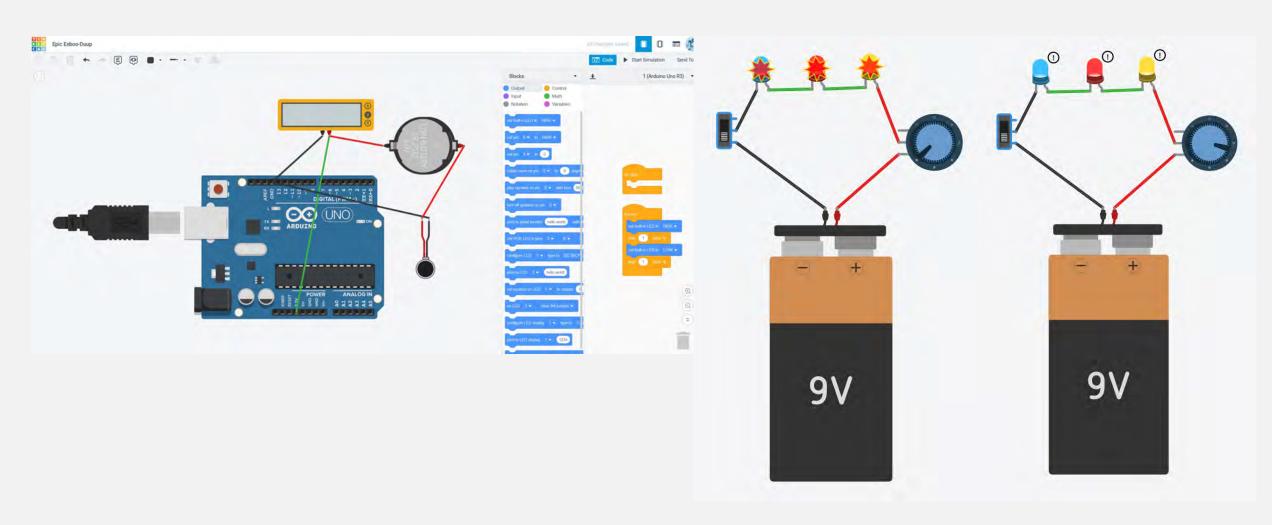
components symbols / schematics







Electronics + TinkerCAD simulate your project





sample: bending the Speak&Spell

- bending guides –old links will need "waybackmachine"
 - http://samvssound.com/2016/06/29/speak-n-spell-part-1-set-first-glitch/
 - https://makezine.com/article/craft/music/how-to-speak-spell-bendin/

getting started – tutorials/wiki

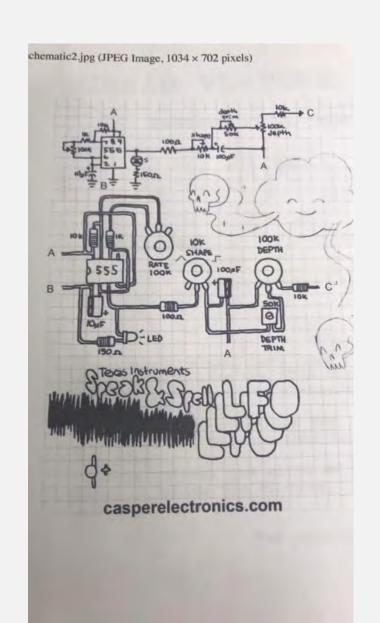
- https://circuitbending.miraheze.org/wiki/Speak_%26_Spell
- <u>http://www.bentstruments.com/speak-spell.html</u>
- https://www.matrixsynth.com/2010/08/wwwpunksynthcom-circuit-bent-speak-and.html
- https://toxicdwarf.wordpress.com/2011/02/11/circuit-bending-speak-and-spell/

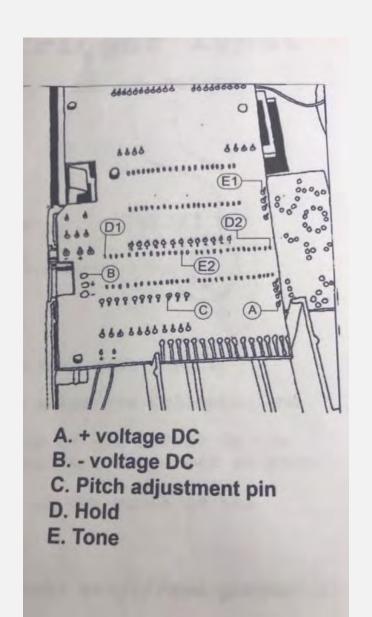
examples of bent toys

- https://cdm.link/2017/03/circuit-bent-instruments-sounds-simply-gorgeous/
- https://www.youtube.com/watch?v=iwBaU-nQ3IQ
- https://www.errorinstruments.com/a-54869669/new-synthe-noise-instruments-for-sale/circuit-bent-speak-and-math/#description
- https://www.youtube.com/watch?v=VzycHDBfx3I
- https://blog.adafruit.com/2020/07/14/sam-of-look-mum-no-computer-refurbs-his-speak-spell-breakout-1-2/



Speak & Spell diagrams









using Makerspace's Pi-400 and Pi-Zero Wkits

- Arrange a free appointment time to work with a kit (30min minimum)
- Have fun!
- Brainstorm by exploring Adafruit's hundreds of learning guides
 - https://learn.adafruit.com/guides/beginner
 - Adafruit Discord <u>https://adafru.it/discord</u>
- Cruise all the projects featured by Raspberry Pi
 - https://projects.raspberrypi.org/en
- Join us again for new projects in our next, "Play with Raspberry Pi, Linux, and Python" and "Robots with Python" workshop

using Makerspace's *Electro* and *Robo* kits

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 - https://learn.adafruit.com/guides/beginner
 - Adafruit Discord <u>https://adafru.it/discord</u>
 - https://learn.adafruit.com/circuitpython-made-easy-on-circuit-playground-express/time-to-get-creative
 - https://learn.adafruit.com/welcome-to-circuitpython/what-is-circuitpython
 - https://learn.adafruit.com/adafruit-circuit-playground-express/overview
 - https://learn.adafruit.com/circuitpython-sound-box
 - https://learn.adafruit.com/circuitpython-fruitbox-sequencer-musically-delicious-step-pattern-generator
 - https://learn.adafruit.com/circuitpython-ble-crickit-rover

moving forward

- The Staff and Student Assistants in the Makerspace are here to help!
- There are O'Reilly video and text tutorials available to help learn the more advanced software (TinkerCAD, MakeCode, Python, etc.) through Library Databases:
 - Search for "oreilly" @
 - http://texastech-ml.hosted.exlibrisgroup.com/V/?func=find-db-1
- YouTube, Hackaday.com, Adafruit, hackster.io, many electronics forums, and most companies offer a wide variety of tutorial assistance

raspberry pi - inspiration

impact

- https://projects.raspberrypi.org/en
- https://raspberryshake.org/

Furby-eyes

https://www.raspberrypi.com/news/these-furby-controlled-raspberry-pi-powered-eyes-follow-you/

podcast - Raspberry Pi + CircuitPython

https://circuitpythonshow.com/episodes/6

Raspberry Pi vs. Arduino Uno

- https://www.arduino.cc/en/hardware
- https://makezine.com/article/technology/arduino/admittedly-simplistic-guide-raspberry-pi-vs-arduino/
- https://www.tomshardware.com/features/raspberry-pi-vs-arduino
- https://www.geeksforgeeks.org/difference-between-arduino-and-raspberry-pi/
- https://www.youtube.com/watch?v=p400etpplDg
- https://www.makerguides.com/arduino-vs-raspberry-pi-what-is-the-difference-between-arduino-and-raspberry-pi/

circuit-bending inspo

- My Little Hacker Playlist of videos bending circuits and hacking toys
 - https://www.youtube.com/watch?v=890PQwlKc18&list=PLjF7R1fz_00XgtmTKH-1Dinp_HjEHK14T
- Blog on retro-technology
 - https://blog.adafruit.com/tag/retrotech/page/2/
- Rise of the Maker Movement
 - https://www.youtube.com/watch?v=bkZw7QI0kCg&list=PLcajvRZA8E0-TmeMyRyafe1XVJVRje0RM&index=27
- CircuitBending
 - https://www.youtube.com/watch?v=FucKzUyeVag&list=PLcajvRZA8E0-0r0Xj7nPbmfEpKVu7VvYs&index=61
- NFC Toys
 - https://www.youtube.com/watch?v=0xawSK2dKqk&list=PLcajvRZA8E0-TmeMyRyafe1XVJVRje0RM&index=96

right to repair

- expert panel
 - https://www.youtube.com/watch?v=NwTjZPvTtVs&list=PLcajvRZA8E0-TmeMyRyafe1XVJVRje0RM&index=37
 - recent debate on Right to Repair

Diode

______ Inductor

-W- Resistor

AC voltage

- https://www.youtube.com/watch?v=N6cGP7x8ErE
- farmers and tractors
 - https://www.youtube.com/watch?v=EPYy_g8Nzml
- Open Source Farming
- https://farmos.org/
- world of Bioprinting
 - https://www.youtube.com/watch?v=XgD04Bime7Q&list=PLcajvRZA8E09bgru8xlqsQrEjgH6
 YM27e&index=62



using Makerspace's Electro, Cutebot, and Robo kits

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 - https://learn.adafruit.com/guides/beginner
 - Adafruit Discord https://adafru.it/discord









projects galore

project-sharing websites (some require membership)

- https://learn.adafruit.com/search?q=raspberry
- https://www.hackster.io/search?i=projects&q=raspberry
- https://www.instructables.com/search/?q=raspberry%20pi%20python&projects=all
- https://hackaday.io/search?term=ras+pi+python
- https://make.co/

Support/Forums/Discord

- Arduino
 - https://discord.com/invite/jQJFwW7
 - https://support.arduino.cc/hc/en-us
- Adafruit
 - http://adafru.it/discord











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thank you!

please share your projects and progress!

"Play with Circuit-Bending" with Sean Scully review this workshop here:

https://ttu.libwizard.com/f/workshop-eval-24-25_emerging_tech

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Makerspace - make@ttu.edu

Director/Librarian - ryan.cassidy@ttu.edu

Workshops - https://guides.library.ttu.edu/make

