HOW EXPLODING BIRTHDAY CAKES AND OTHER BIZARRE IDEAS COME TO LIFE!

By: Barry Tarlton

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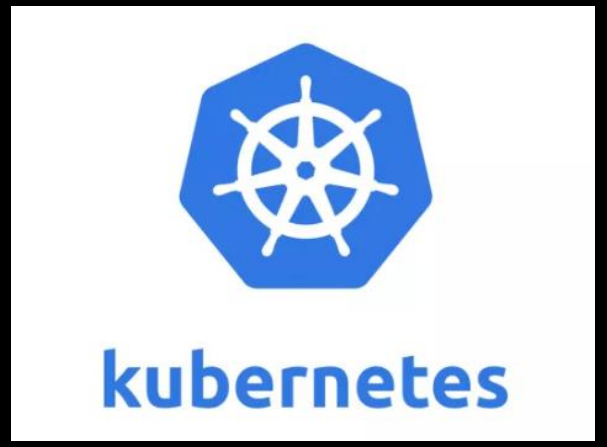
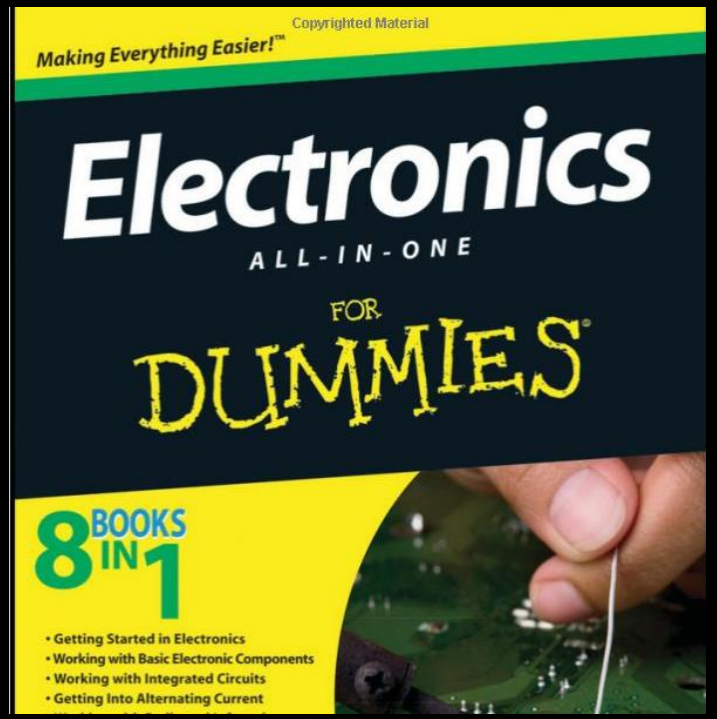
Link to slides:

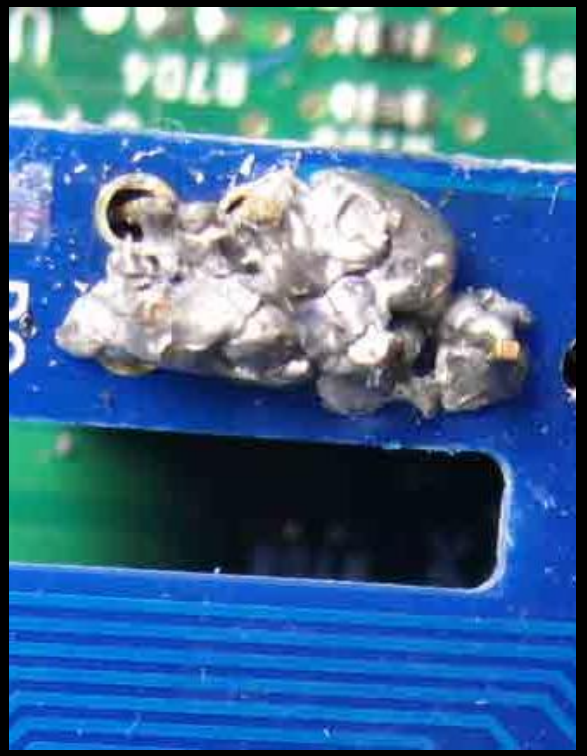
MY EXPERIENCE/ BACKGROUND



NO ELECTRICAL OR MECHANICAL ENGINEERING FORMAL STUDIES

- Soldering Novice
- Electronics Noob



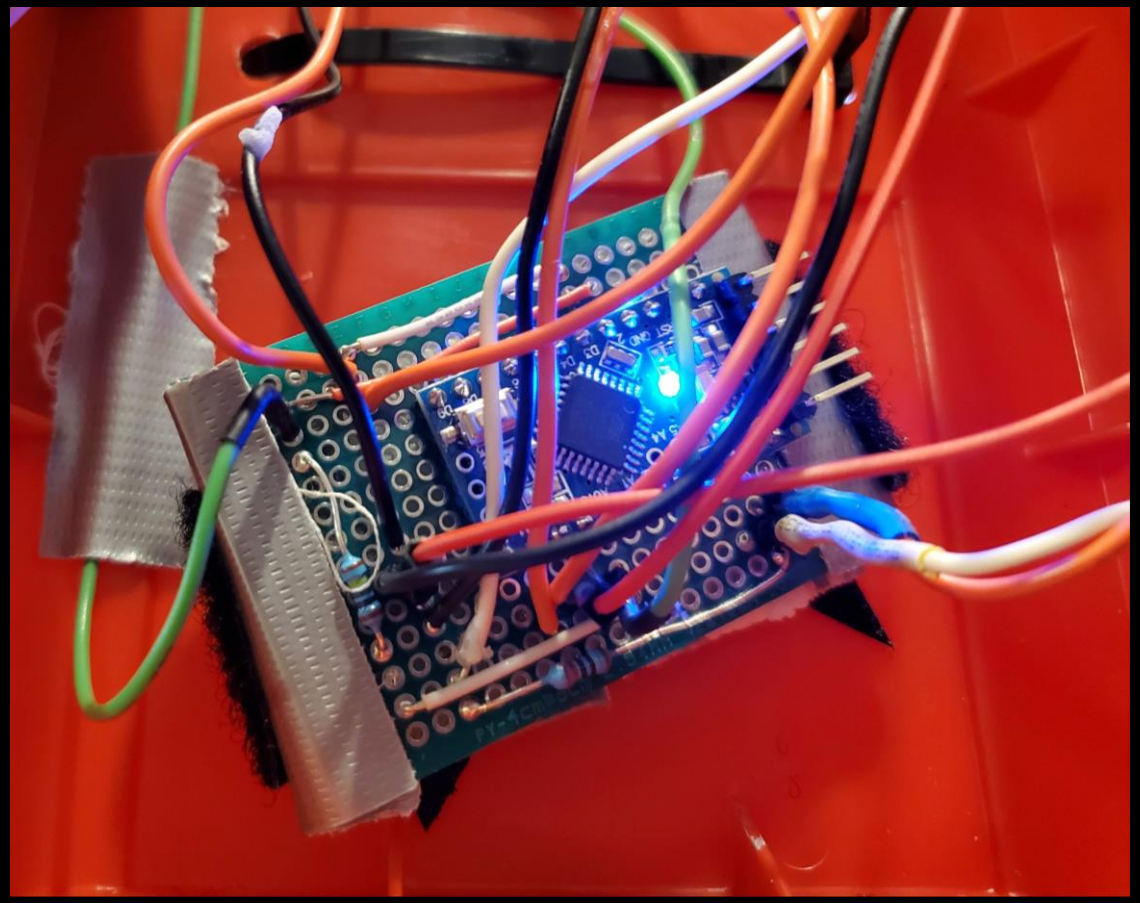


FAIR WARNING

BUT…

WITH THE RIGHT MOTIVATION AND PASSION ANYONE CAN DO TOTALLY AWESOME THINGS!

JUMP RIGHT INTO IT



INTERACTIVE TARGET

GOAL

- Create a target that reacts when hit

SHOOTING GALLERY


I JUST LIKE TO VOLUNTEER
VOLUNTEERING IS MY FAVORITE
makeameme.org


Leader

COMPONENTS

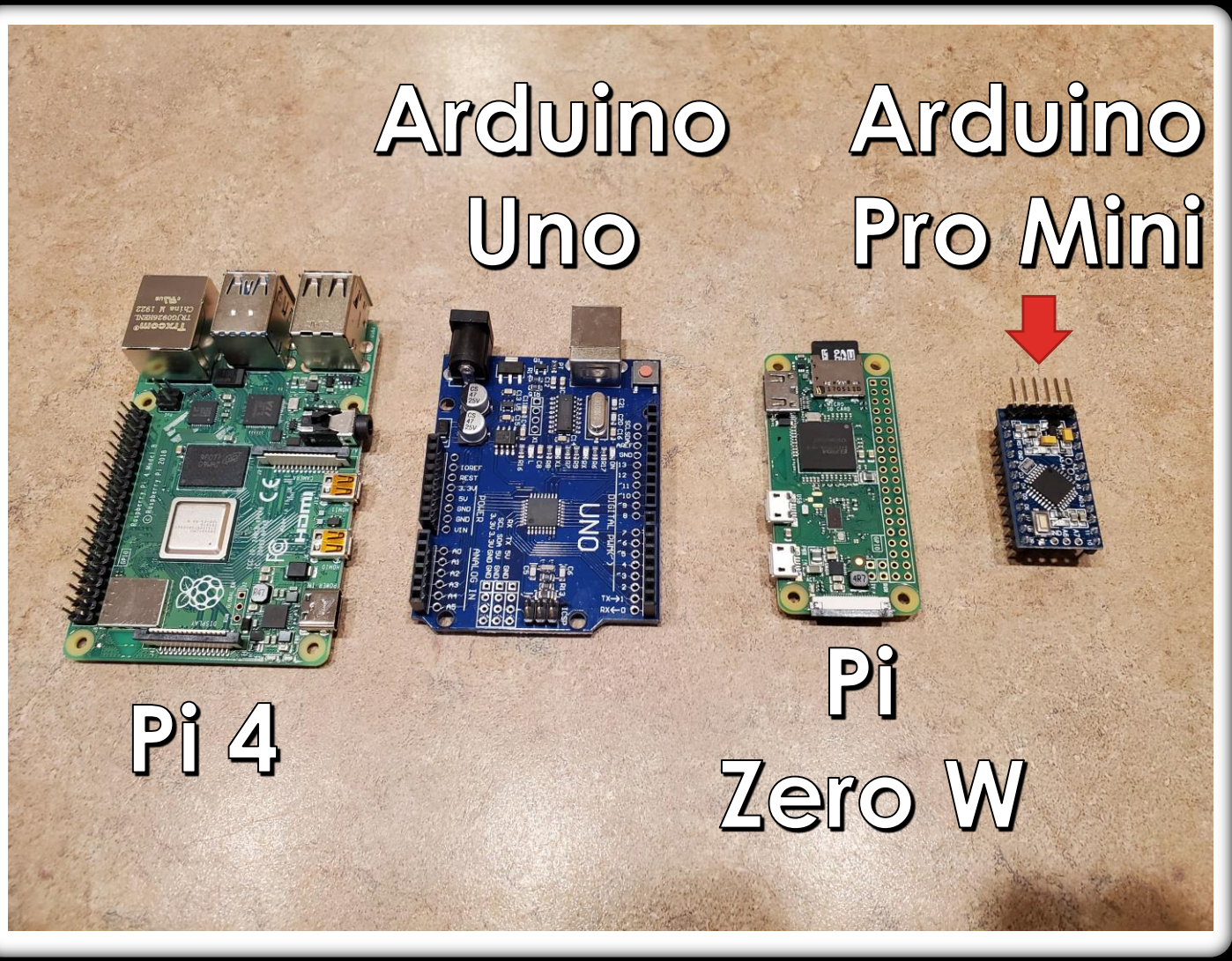
- Speaker
- LEDs
- Arduino Pro Mini
- Piezo Vibration Sensor

ARDUINO PRO MINI

- Smaller form factor
- based on the ATmega328
- 14 digital input/output pins (6 PWM)
- two version
  - 3.3V & 8 MHz
  - 5V and 16 MHz

SIZE COMPARISONS

- Pro Mini is very small
- But still can do most things it's bigger brother can do!
- Virtually same Chipset as Arduino Uno (ATmega328)

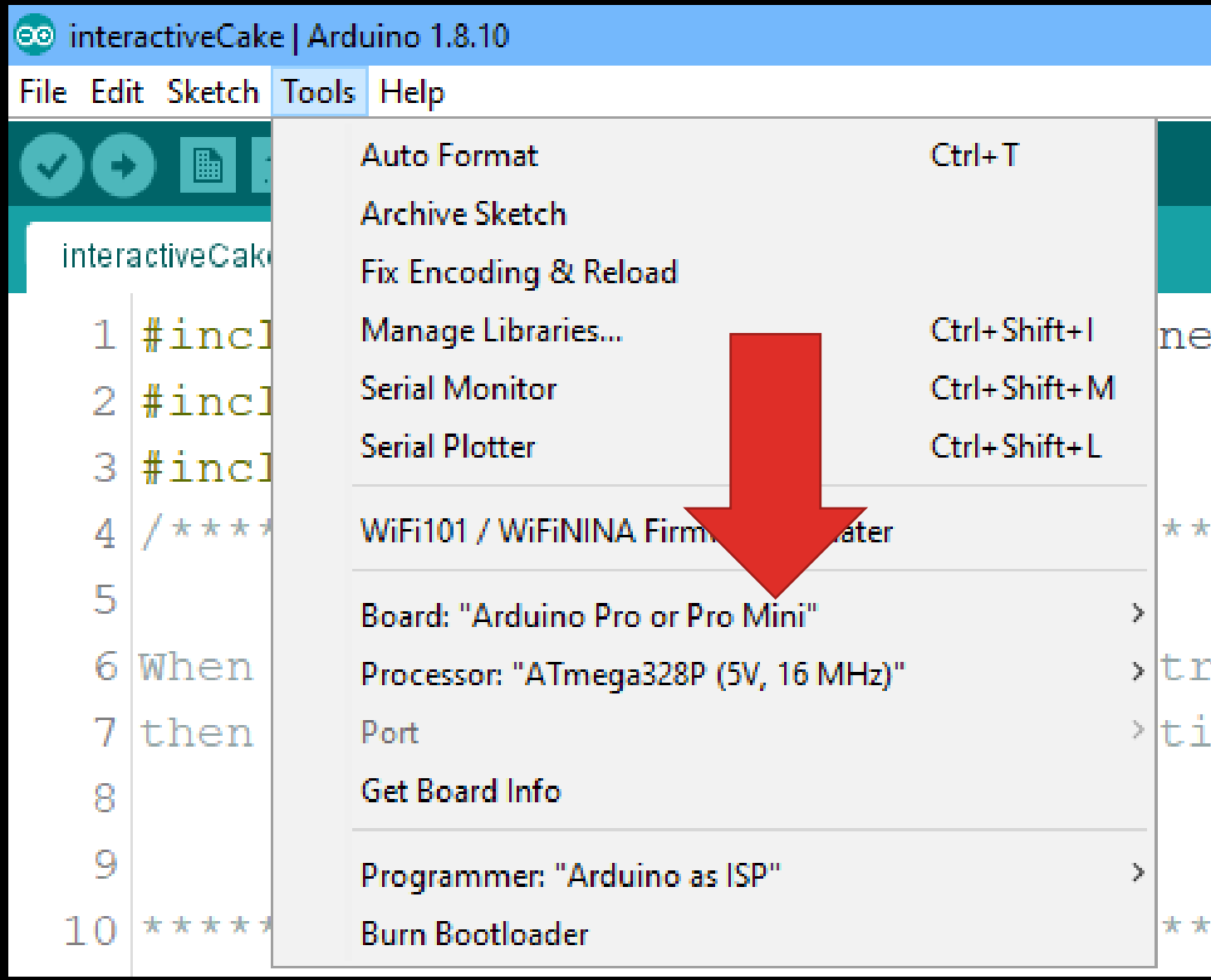


PRO MINI REQUIRES ADAPTER

- Need Adapter to program Arduino Pro Mini.
- This plugs into the six header pins and gives a Mini-USB connection

PRO MINI REQUIRES ADAPTER

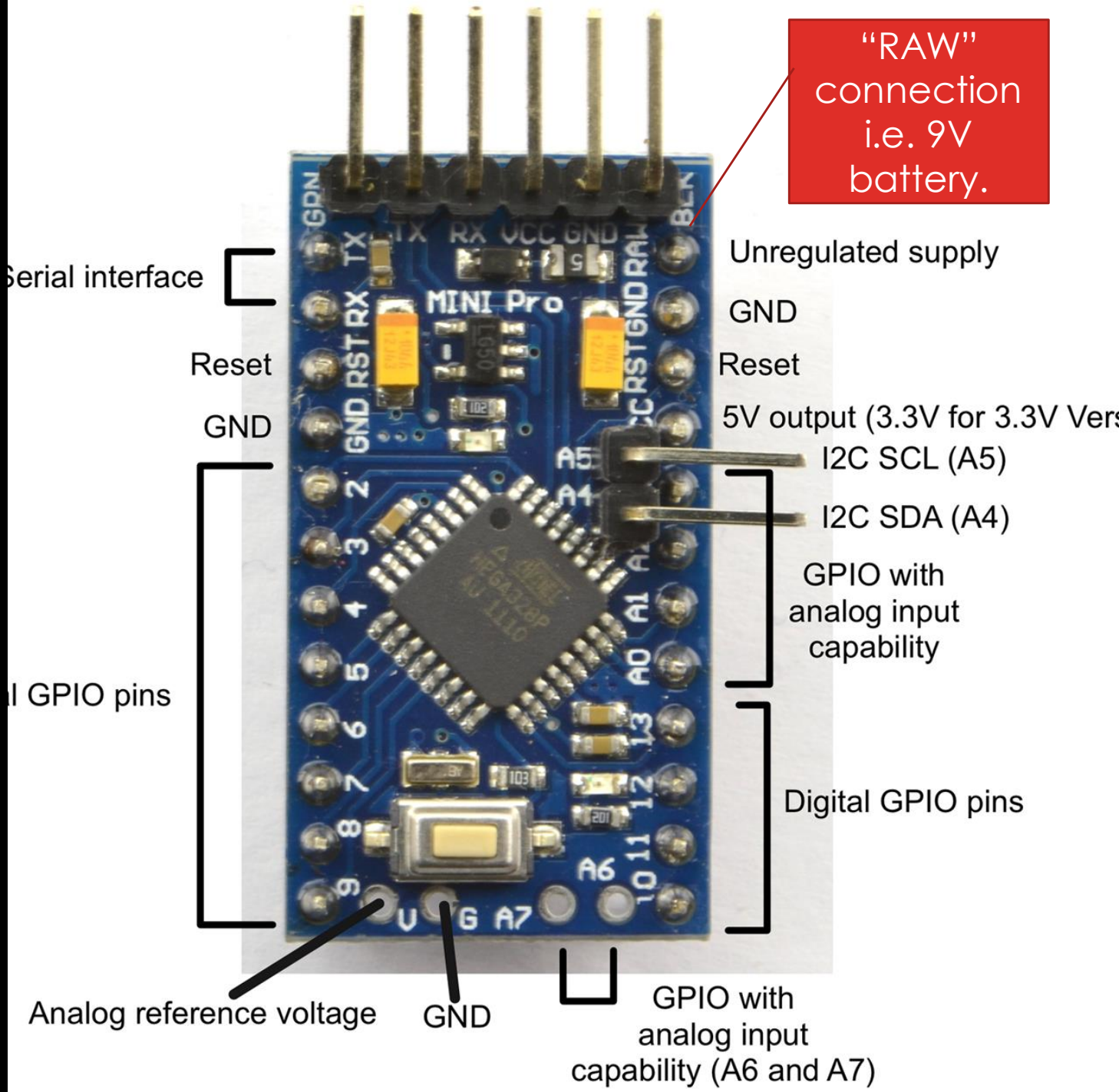
- Need Adapter to program Arduino Pro Mini.
- This plugs into the six header pins and gives a Mini-USB connection
- In Arduino IDE, be sure to choose the right Board!



POWER ARDUINO MINI

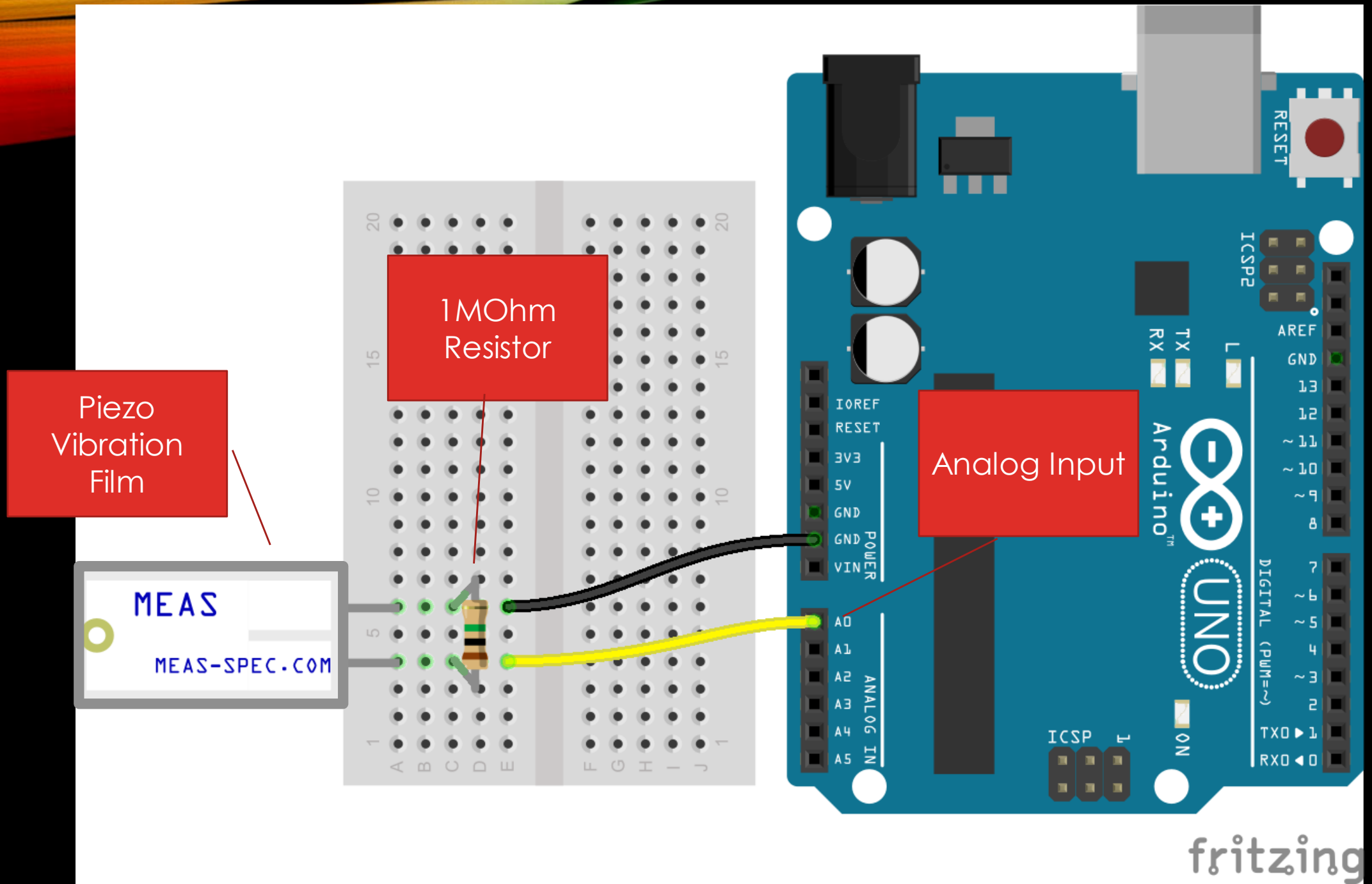
- With an FTDI cable or breakout board connected to its six pin header
- a regulated 3.3V or 5V supply (depending on the model) on the Vcc pin.
- Voltage regulator on board so it can accept voltage up to 12VDC. If supplying unregulated power connect to the "RAW" pin, not VCC.

RAW For supplying a raw voltage to the board.
VCC The regulated 3.3 or 5 volt supply.
GND Ground pins.



VIBRATION SENSORS

- Simple Digital Switch
  - Either On or OFF
- Analog Sensors
  - Detect Magnitude
  - Requires Analog input capabilities.
  - Ex: Piezo Film


Piezo Vibration Film
1MOhm Resistor
Analog Input
MEAS
MEAS-SPEC.COM
RESET
ICSP2
AREF
GND
13
12
~11
~10
~9
8
TX
RX
L
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
Arduino™
UNO
A0
A1
A2
A3
A4
A5
ANALOG IN
DIGITAL (PWM=~)
7
~6
~5
4
~3
2
TX0 ▶ 1
RX0 ◀ 0
ICSP
1
ON
fritzing

SAMPLE PIEZO CODE

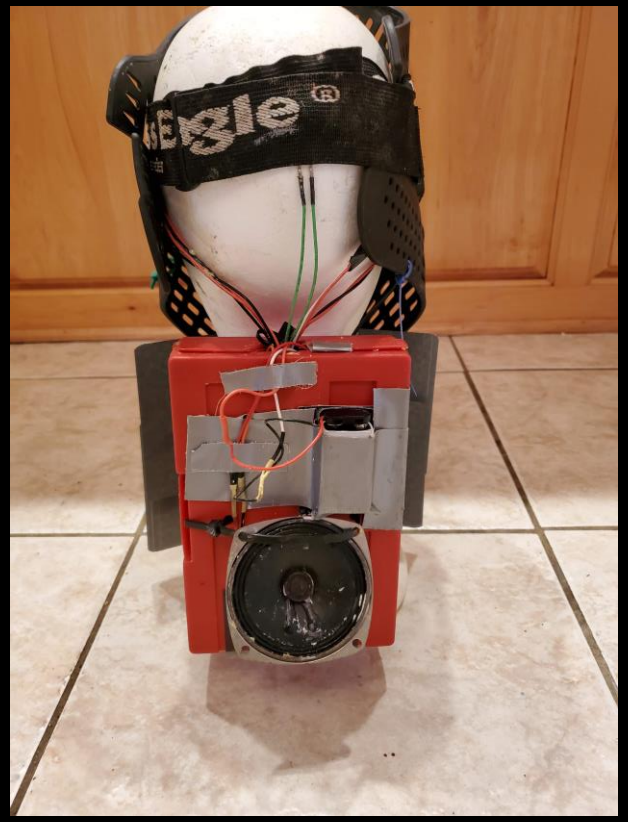
https://learn.sparkfun.com/tutorials/piezo-vibration-sensor-hookup-guide

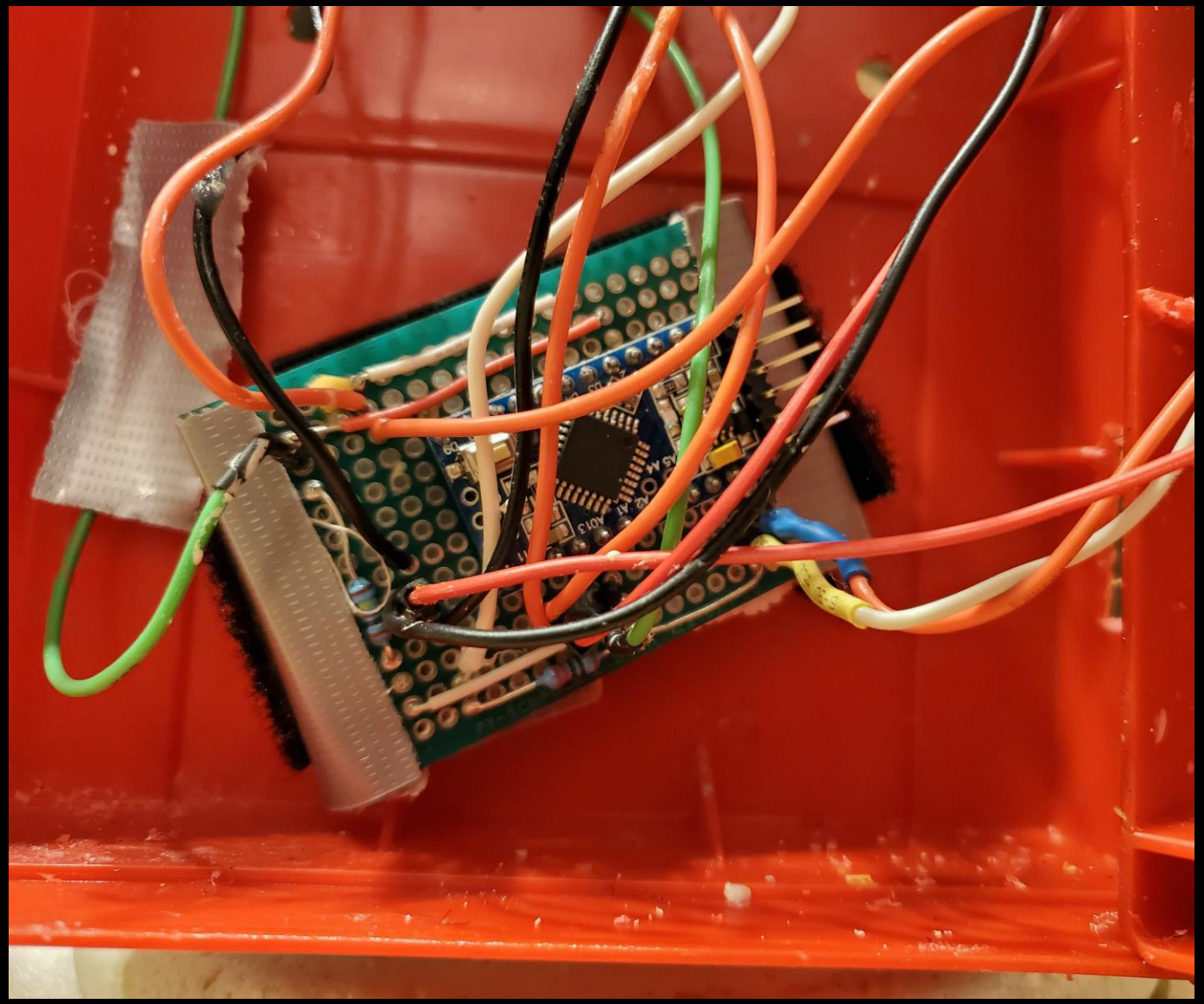
```
const int PIEZO_PIN = A0; // Piezo output

void setup()
{
  Serial.begin(9600);
}

void loop()
{
  // Read Piezo ADC value in, and convert it to a voltage
  int piezoADC = analogRead(PIEZO_PIN);
  float piezoV = piezoADC / 1023.0 * 5.0;
  Serial.println(piezoV); // Print the voltage.
}
```

DOING MULTIPLE THINGS WITH AN ARDUINO





The Obligatory Blink Demo

BASIC PROGRAMMING IN AN ARDUINO

```
25 // the setup function runs once when you press reset or power the board
26 void setup() {
27   // initialize digital pin LED_BUILTIN as an output.
28   pinMode(LED_BUILTIN, OUTPUT);
29 }
30
31 // the loop function runs over and over again forever
32 void loop() {
33   digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
34   delay(1000);                       // wait for a second
35   digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
36   delay(1000);                       // wait for a second
37 }
```

SimpleMultithreading §

```
1 // set flags
2 int howLongToDoSomething = 2000; // how long to do something in milli seconds.
3 unsigned long whenDidYouStartDoingSomething = 0;  // a timer when we started doing something
4 unsigned long howLongToWaitToDoItAgain = 1000;  // a timer how long to wait to do something again
5
6 boolean areDoingSomething = false;  // Are we doing Something?
7
8
```

SimpleMultithreading §

```
// set flags
int howLongToDoSomething = 2000; // how long to do something in milli seconds.
unsigned long whenDidYouStartDoingSomething = 0;  // a timer when we started doing something
unsigned long howLongToWaitToDoItAgain = 1000;  // a timer how long to wait to do something again

boolean areDoingSomething = false;  // Are we doing Something?


void loop() {

  boolean shouldIDoSomething = readSensorThing();
  if(!areDoingSomething && shouldIDoSomething){
    // start doing something now!
    whenDidYouStartDoingSomething = millis();
    areDoingSomething = true;
    // your do something code here!
    // like turn a light on
  }
```

SimpleMultithreading §

```
// set flags
int howLongToDoSomething = 2000; // how long to do something in milli seconds.
unsigned long whenDidYouStartDoingSomething = 0;  // a timer when we started doing something
unsigned long howLongToWaitToDoItAgain = 1000;  // a timer how long to wait to do something again

boolean areDoingSomething = false;  // Are we doing Something?


void loop() {

  boolean shouldIDoSomething = readSensorThing();
  if(!areDoingSomething && shouldIDoSomething){
    // start doing something now!
    whenDidYouStartDoingSomething = millis();
    areDoingSomething = true;
    // your do something code here!
    // like turn a light on
  }

  if(millis()- whenDidYouStartDoingSomething > howLongToDoSomething){
    areDoingSomething = false;
    whenDidYouStartDoingSomething = 0;
    // your stop doing something code here
    // like turn light off
  }
 }
```

```
// set flags
int howLongToDoSomething = 2000; // how long to do something in milli seconds.
int howLongToDoOTHERthing = 3000; // how long to do Other thing in milli seconds.
unsigned long whenDidYouStartDoingSomething = 0;  // a timer when we started doing something
unsigned long whenDidYouStartDoingOTHERthing = 0;  // a timer when we started doing Other thing
unsigned long howLongToWaitToDoItAgain = 1000;  // how long to wait before doing something again
unsigned long howLongToWaitToDoOTHERThingAgain = 1000;  // how long to wait before doing something again
// can also have flags based on Sensors

boolean areDoingSomething = false;  // Are we doing Something?
boolean areDoingOTHERthing = false;  // Are we doing OTHERthing?

void loop() {

  if(!areDoingSomething){
    // start doing something now!
    whenDidYouStartDoingSomething = millis();
    areDoingSomething = true;
    // your do something code here!
    // like turn a light on
  }
  if(!areDoingOTHERthing  && SOME_CHECK_TO_SEE_IF_WE_SHOULD_DO_OTHER_THING){
    // start doing OTHERthing now!
    whenDidYouStartDoingOTHERthing = millis();
    areDoingOTHERthing = true;
    // your do OTHERthing code here!
    // like play sound
  }

  if(millis()- whenDidYouStartDoingSomething > howLongToDoSomething){
    areDoingSomething = false;
    whenDidYouStartDoingSomething = 0;
    // your stop doing something code here
    // like turn light off
  }
  if(millis()- howLongWeBeenDoingOTHERthingNow > howLongToDoOTHERthing){
    areDoingSomething = false;
    whenDidYouStartDoingSomething = 0;
    // your stop doing OTHERThing code here
```

REACTIVE TARGET LINKS

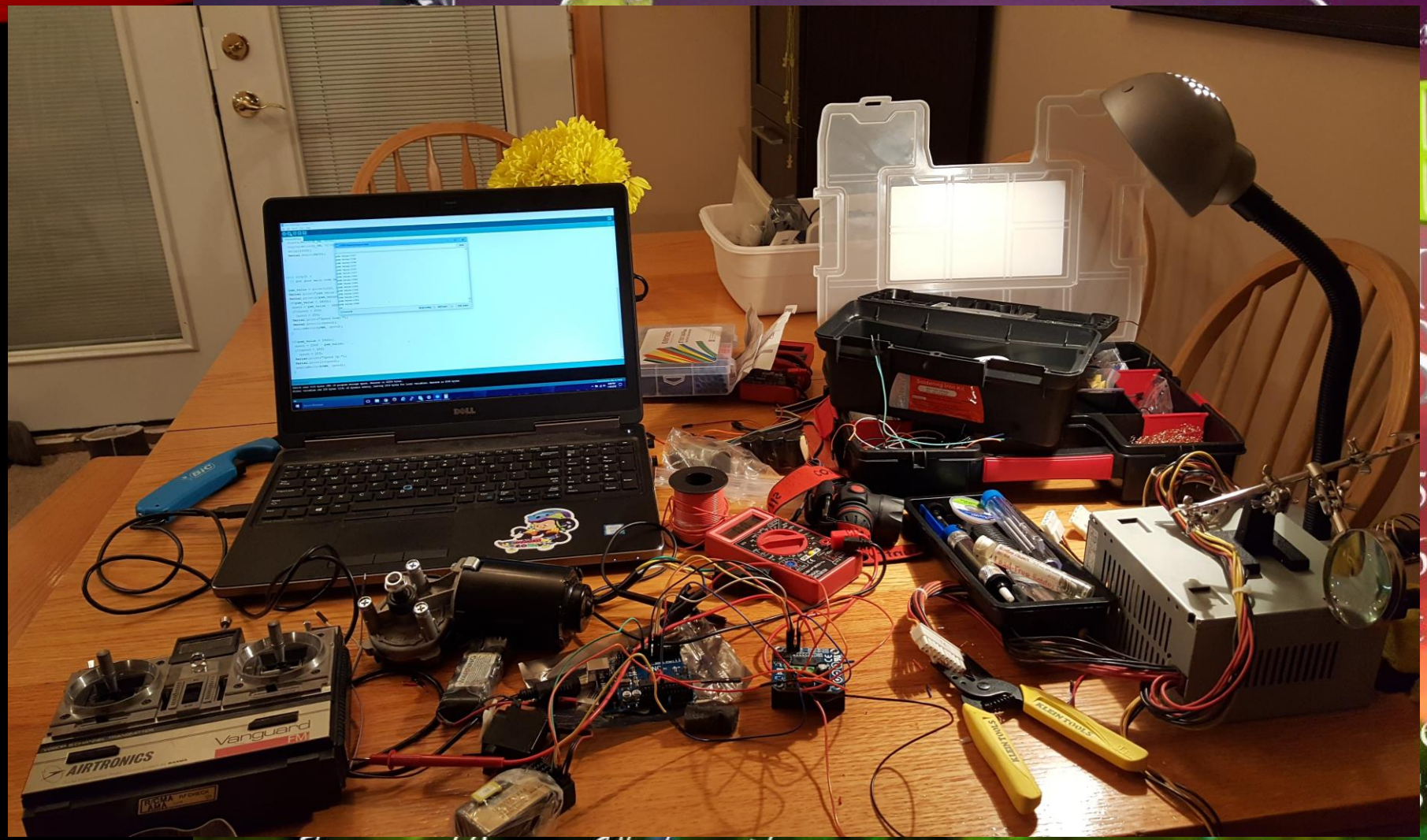
- Arduino Source Code:
- https://github.com/javaplus/simple_target

- Piezo Sensor Tutorial with Arduino:
- https://learn.sparkfun.com/tutorials/piezo-vibration-sensor-hookup-guide

- Using Analog to Digital Convertor with Raspberry PI tutorial
- https://learn.adafruit.com/mcp3008-spi-adc/python-circuitpython

- Piezo sensor Tutorial:
- https://www.arduino.cc/en/tutorial/knock

Waverly High School
presents



Treasured Images Photography

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The
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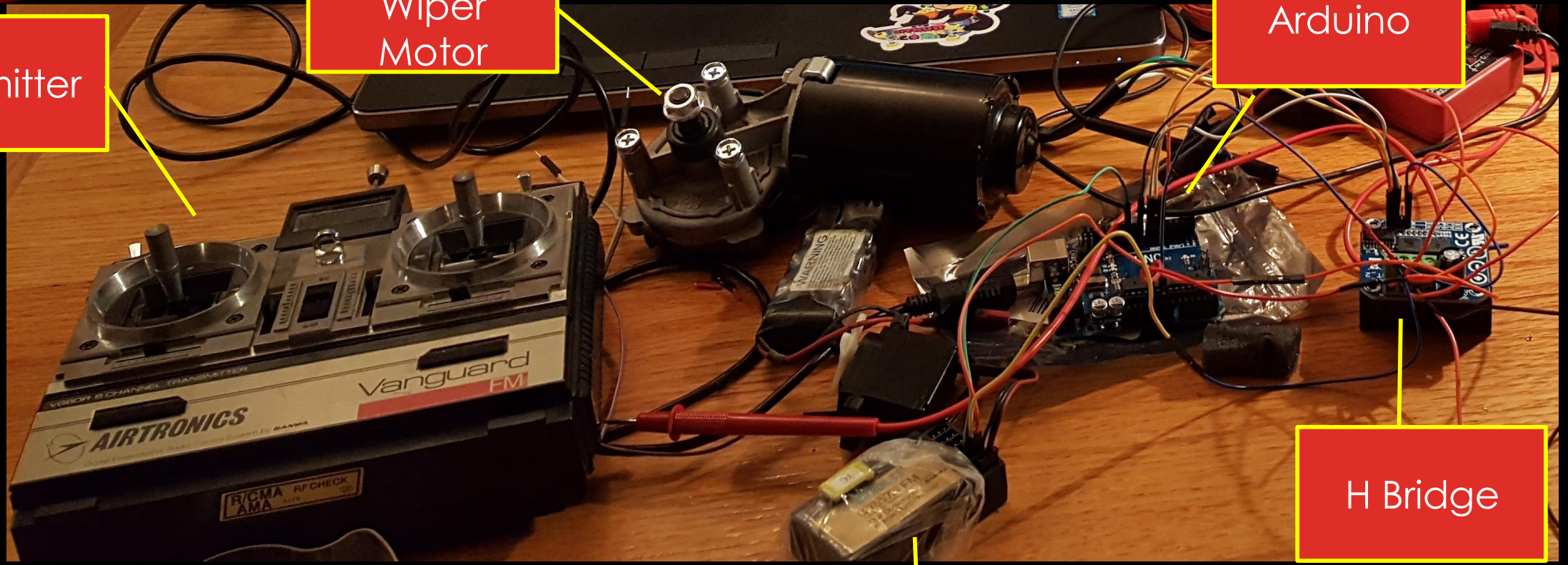
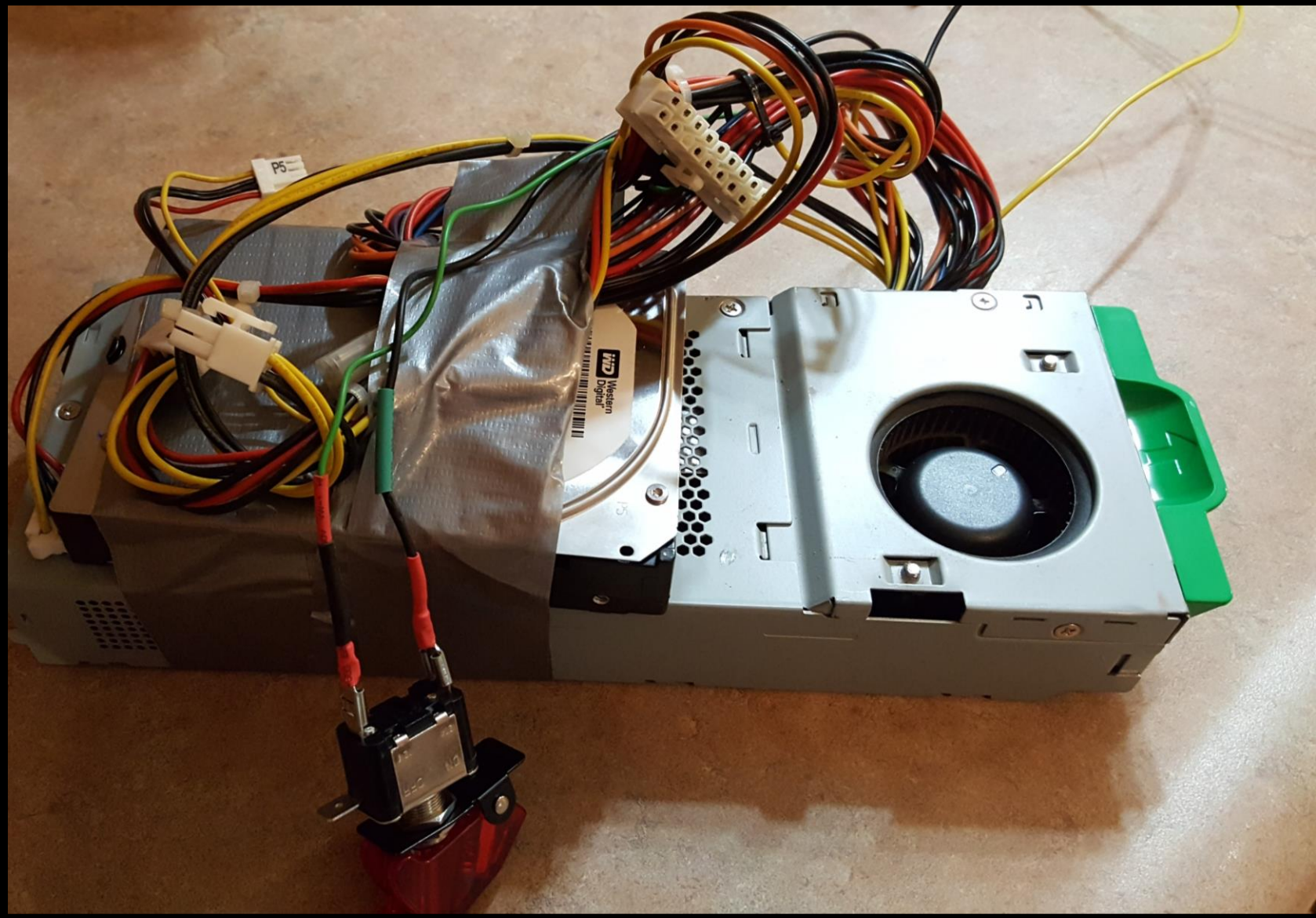
LATEST PROJECT



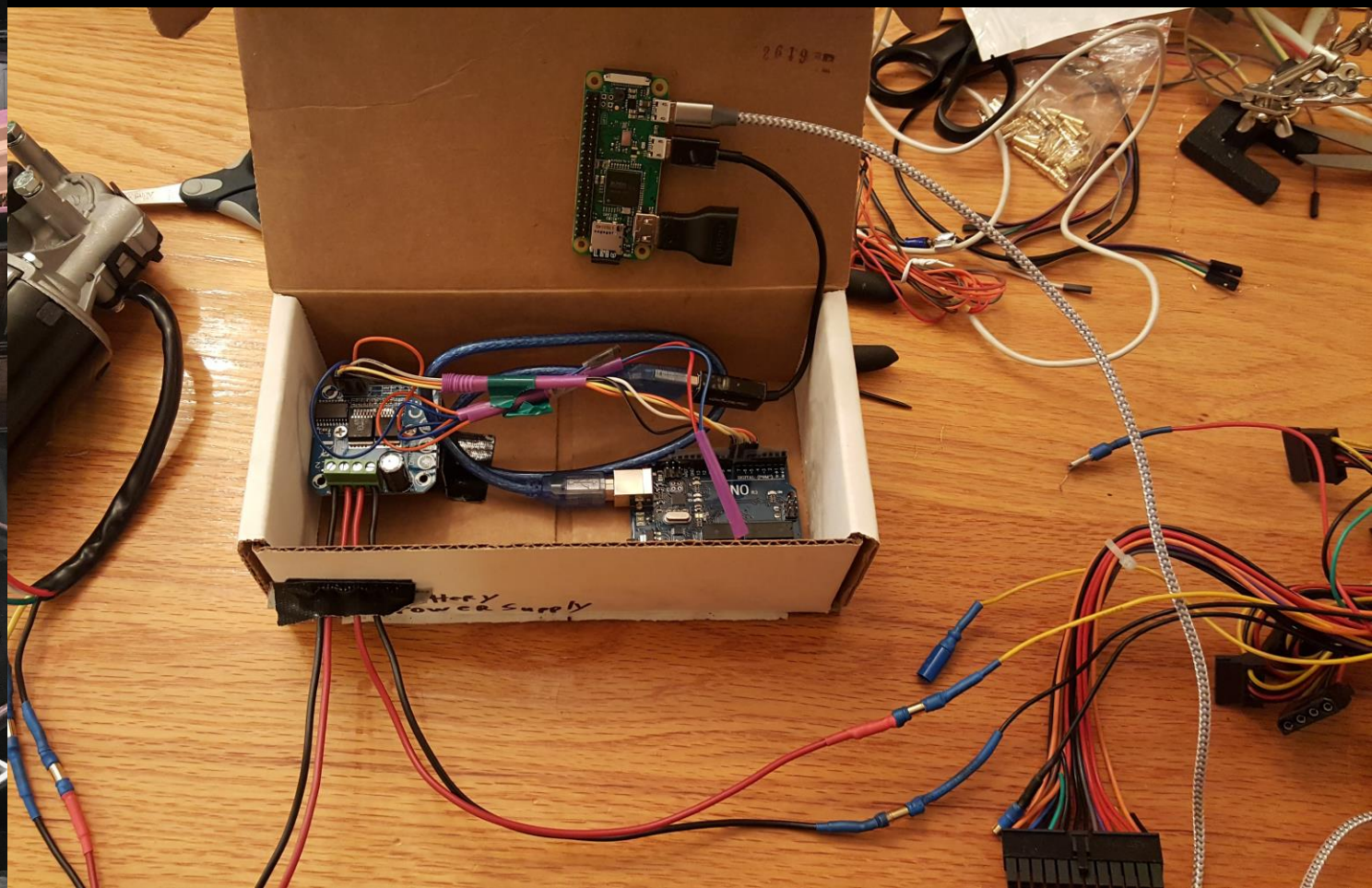
NEED POWER OPTIONS

- Battery back up (like to charge your phone)

- OR anything with 5 volts DC out
- Preferably 2 or more amps for Pi 3 and Pi 4
- PC Power supply great for conjunction with 12Volt power items.



SCENE COMMANDER PROJECT



SCENE COMMANDER LINKS

- Scene Commander Video demo:
- https://www.youtube.com/watch?v=zPYgqCc3WGo

- Scene Commander Dress Rehearsal (actually moving trees)
- https://www.youtube.com/watch?v=qXxWavTGCvk

- Scene Command source code
- Arduino : https://github.com/javaplus/hBridgeController_arduino/blob/master/RemoteAPI/RemoteAPI.ino
- Mobile App(Ionic): https://github.com/javaplus/motor_mobile
- Raspberry PI Python App: https://github.com/javaplus/pi_motor_api

H-BRIDGE LINKS

- H-Bridge Arduino Demo Code
- https://github.com/javaplus/hBridgeController_arduino/blob/master/TestHBridge/TestHBridge.ino

- Using H-Bridge Tutorial:
- https://www.instructables.com/id/Motor-Driver-BTS7960-43A/

- H-Bridge Tutorial Video:
- https://www.youtube.com/watch?v=PUL5DZ9TA2o

- HBridge Store Link:
- https://www.amazon.com/DEVMO-BTS7960B-Stepper-H-Bridge-Arduino/dp/B07SZ4T699/ref=sr_1_1?keywords=BTS7960B&qid=1577917404&s=electronics&sr=1-1
- Remote Control with Arduino:
- https://www.sparkfun.com/tutorials/348

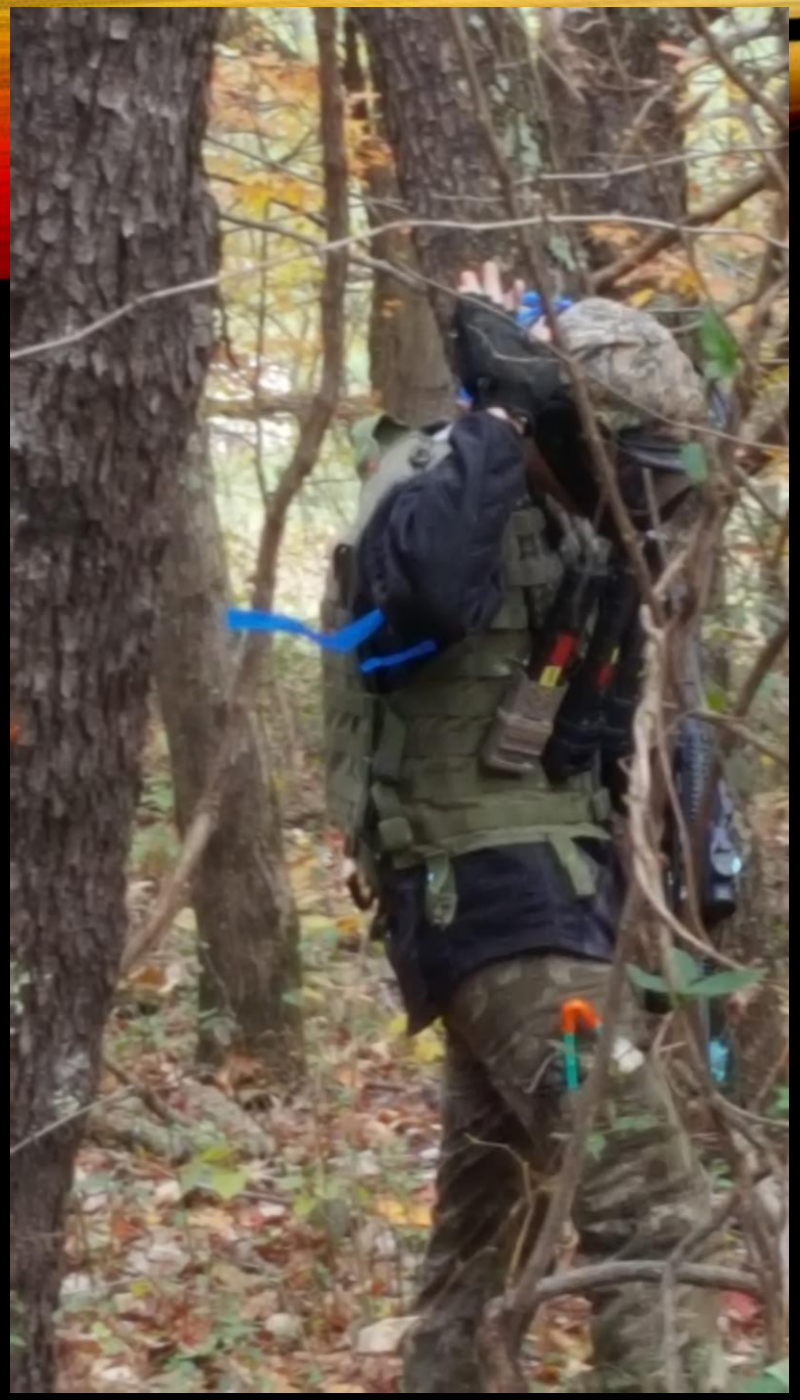
GAME COMMANDER PROJECT

GOAL: Automate the Running of the Games

PROBLEMS

When do we start?

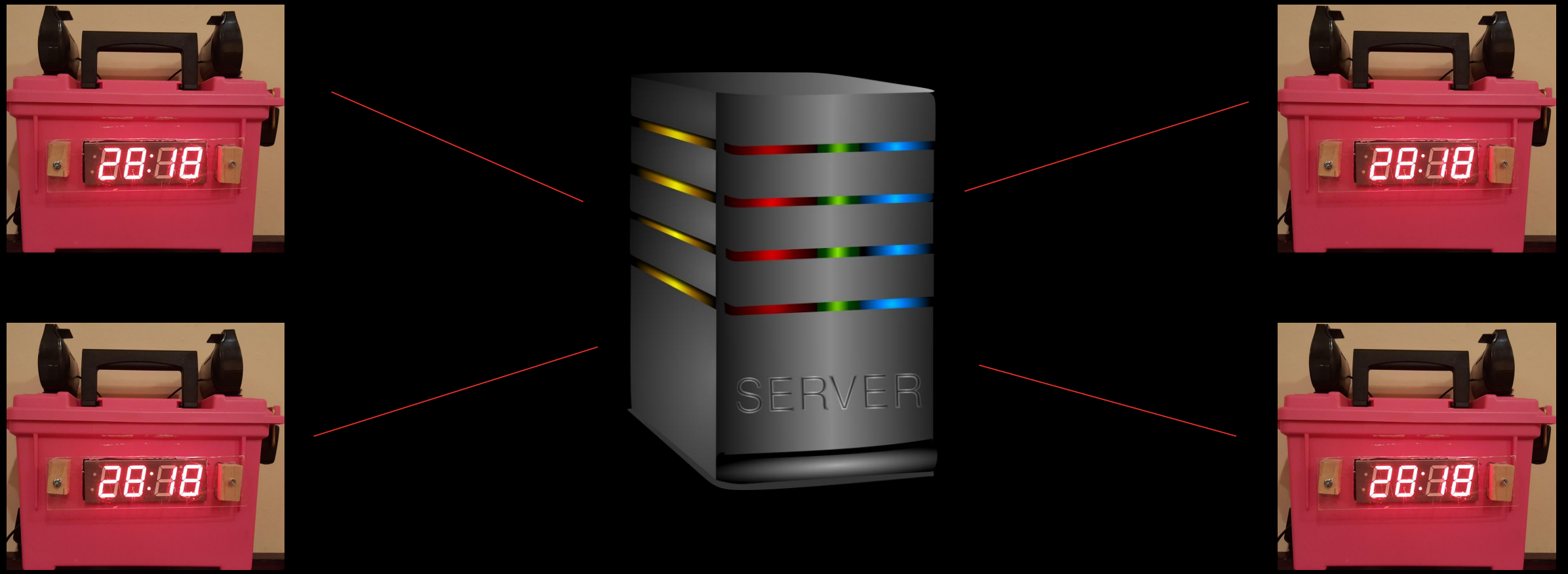

Is the round over?
Riley
3



I got hit, when can I go back in?

MY SOLUTION: DISTRIBUTED SPEAKING TIMERS

MY SOLUTION: DISTRIBUTED SPEAKING TIMERS

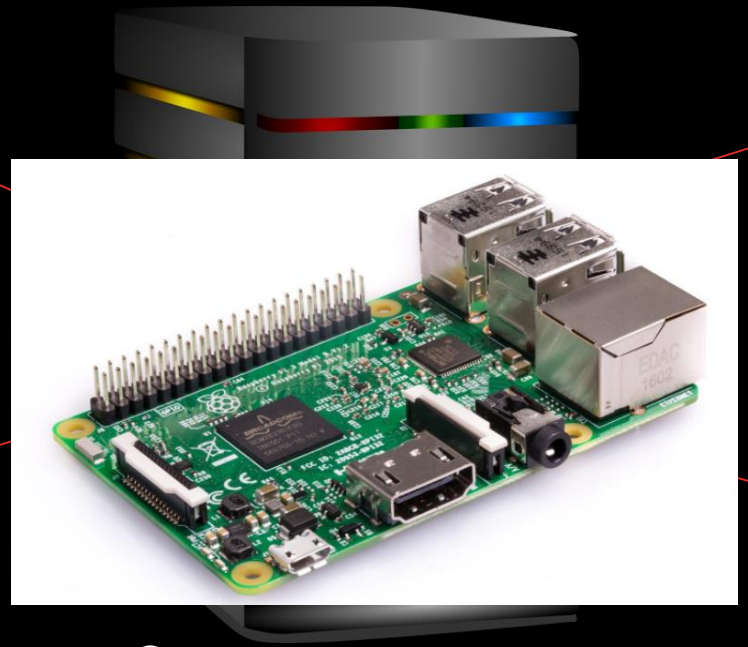


IN THE TREES

PI ZERO W

PI ZERO W

PI ZERO W

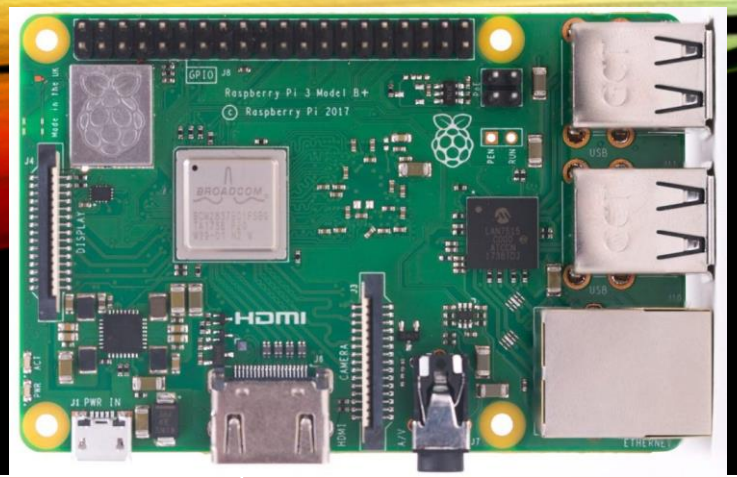


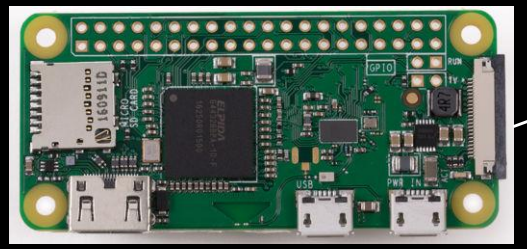
RASPEBERRY PI 3

PI ZERO W

PI MODEL COMPARISON

PI 3



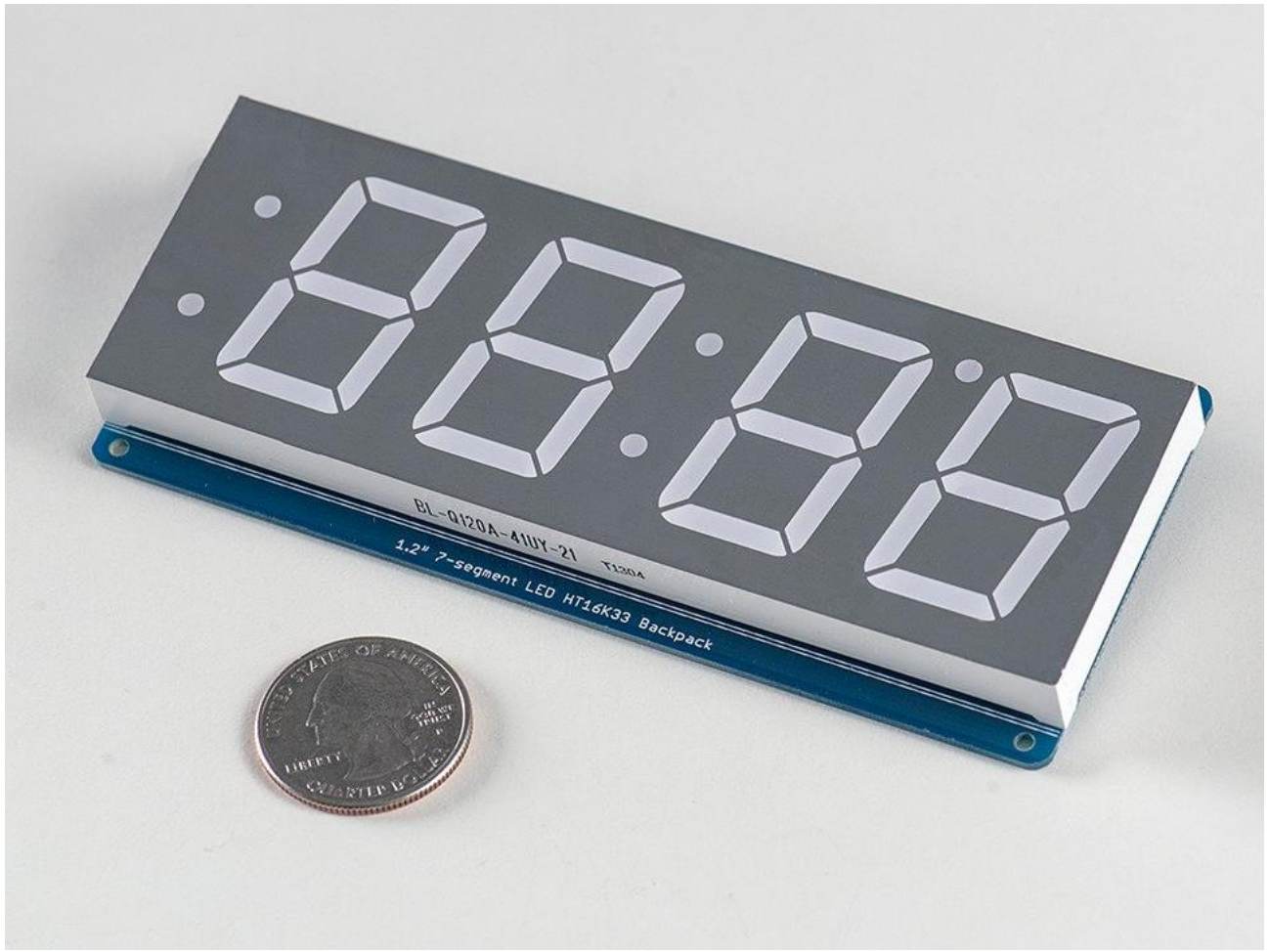


PI Zero

Name	Pi 3 B+	Pi Zero W
Price:	$35	$10 - $15
Processor:	Quad 1.4GHz (standard Pi 3 1.2GHz)	Single core1GHz
Memory:	1 GB DDR2	512MB
USB Ports:	4 USB	1 micro USB
HDMI :	1 standard	1 mini
Audio:	3.5mm Jack	N/A
Uses:	Desktop learning Server or Heavy processing	Less process intensive tasks that need connectivity. (e.g. Motion activated camera that uploads to the cloud)

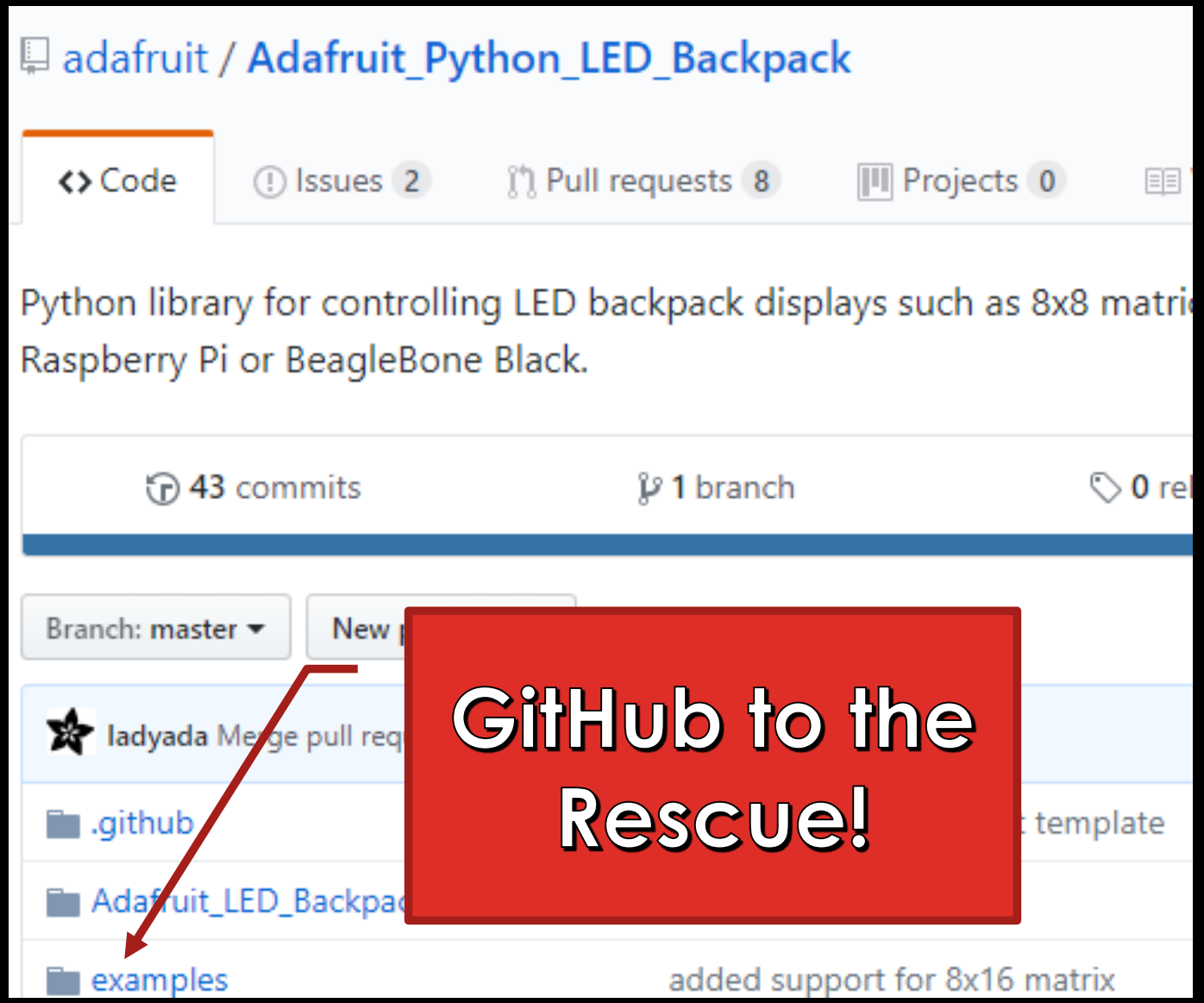
7 SEGMENT DISPLAY

- Adafruit 7 Segment Display With I2C Backpack
- 1.2” tall
- Controlled with just 2 pins
- https://chicagodist.com/



CONTROLLING CLOCK DISPLAY

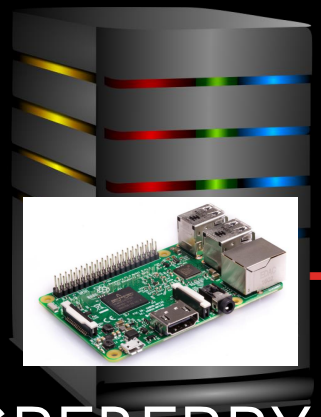
- Controlling Display from Code
- Only a few examples most for Arduino ☹
- https://learn.adafruit.com/matrix-7-segment-led-backpack-with-the-raspberry-pi/using-the-adafruit-library
- https://github.com/adafruit/Adafruit_Python_LED_Backpack



HOW DO WE COMMUNICATE

- Create a wireless network outside
- With no internet access.

DHCP Server



RASPEBERRY PI 3

TP-LINK N300 Long Range 11n 2.4G Wireless Outdoor Access Point, IP65 Waterproof, Ideal for Garden Wireless, w/Passive PoE Injector, Flexible Installation, Free EAP Controller Software (EAP110-Outdoor)

4.0 out of 5 stars ▾ 140 customer reviews | 62 answered questions

List Price: ~~$69.99~~
With Deal: $39.99 ✓prime

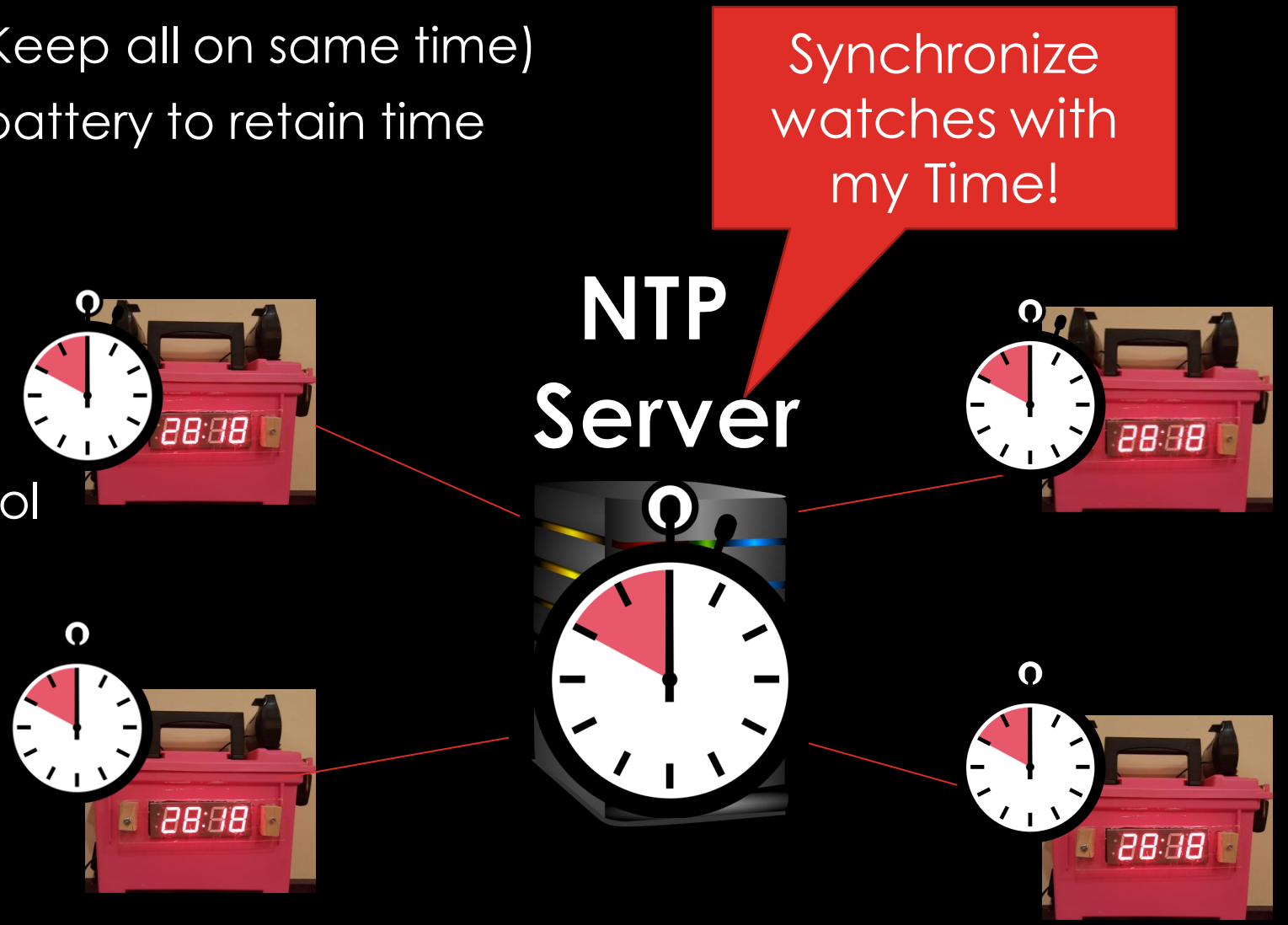
PI ZERO W

PI ZERO W

KEEPING TIME

- How to Synchronize time (Keep all on same time)
- No internet and no clock battery to retain time
- Solution???
- Don't build a new one

- NTP – Network Time Protocol



COMMUNICATING ACROSS PIES EVENT DRIVEN ARCHITECTURE

- Mosquitto and MQTT
- https://pypi.python.org/pypi/paho-mqtt

MOSQUITTO AND MQTT

- Publish / Subscribe Pattern
- If timer boxes restart, last known message still on queue, so pick up where they left off

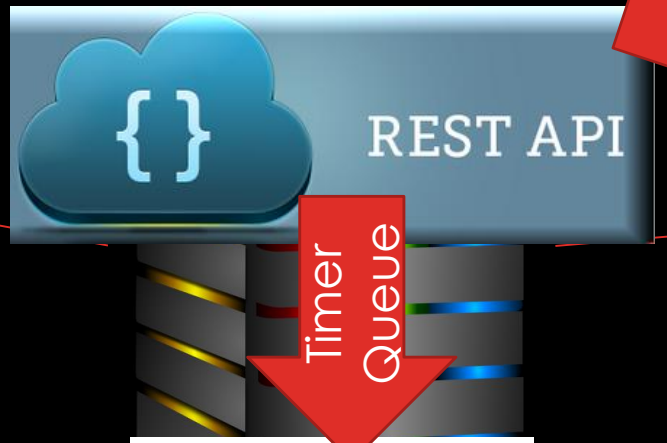
Timer Box Code

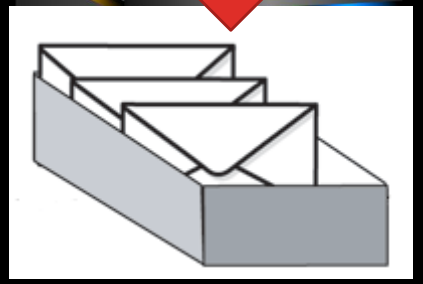
```
import paho.mqtt.client as mqtt
import json
import logging
import sys
import timer
import math

# The callback for when the client receives a CONNACK
def on_connect(client, userdata, flags, rc):
    print("Connected with result code "+str(rc))

    # Subscribing in on_connect() means that if we los
    # reconnect then subscriptions will be renewed.
    #client.subscribe("$SYS/#")
    client.subscribe("timer/timer")



# The callback for when a PUBLISH message is received
def on_message(client, userdata, msg):
    print(msg.topic+" "+str(msg.payload))
    jsonRequest = json.loads(msg.payload)
    timeToEnd = jsonRequest['timeToEnd']
    speaktime = jsonRequest['speaktime']
    speakinterval = jsonRequest['speakinterval']
    timer.stopCountDown()
    timeToEndLong = float(timeToEnd)
    timeToEndInt = int(math.floor(timeToEndLong))
    timer.countDown(timeToEndInt, speaktime,speakinter
```

REST CALLS TO RASPBERRY PIES

- REST API on Server to Submit Message to Queue

/timer

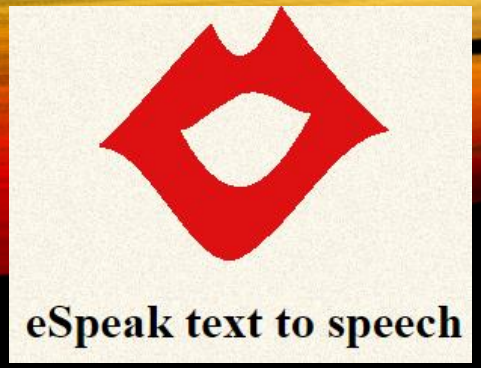




Queue

REST CALLS IN PYTHON

- Flask Framework
- Easy to use for HTTP request handling



MAKING THEM TALK!!!

- eSpeak – Open Source Text To Speech software
- Update timer message format to submit messages at specific times
- http://espeak.sourceforge.net/

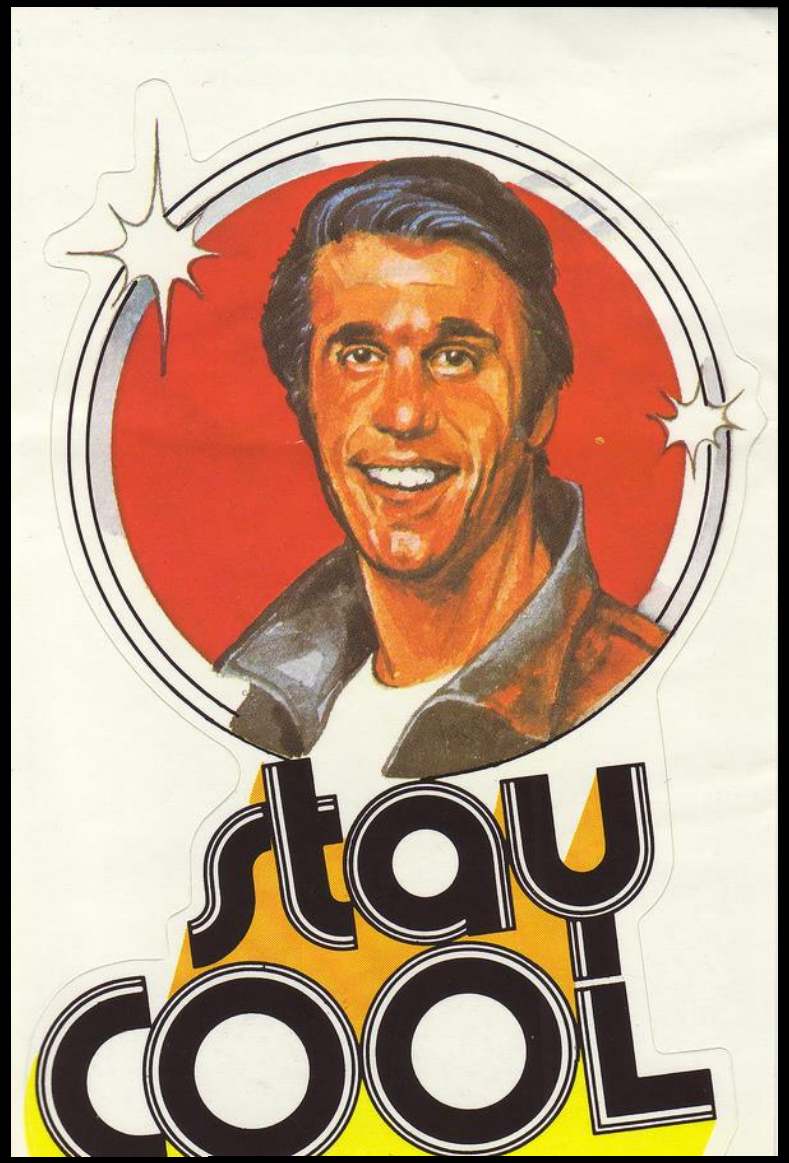
Request Message

```
{
  "minutes": "28",
  "speaktime": [
    {
      "time": "27:00",
      "say": "Make your plans ready.  Make your plans ready",
      "parms": "-s 160"
    },
    {
      "time": "26:00",
      "say": "Test Fire, Test Fire, Test Fire",
      "parms": "-s 160"
    },
    {
      "time": "25:10",
      "say": "10,  9, 8, 7, 6, 5, 4, 3, 2, 1, GO GO",
      "parms": "-s 110"
    }
    ...
```

DEMO TIME

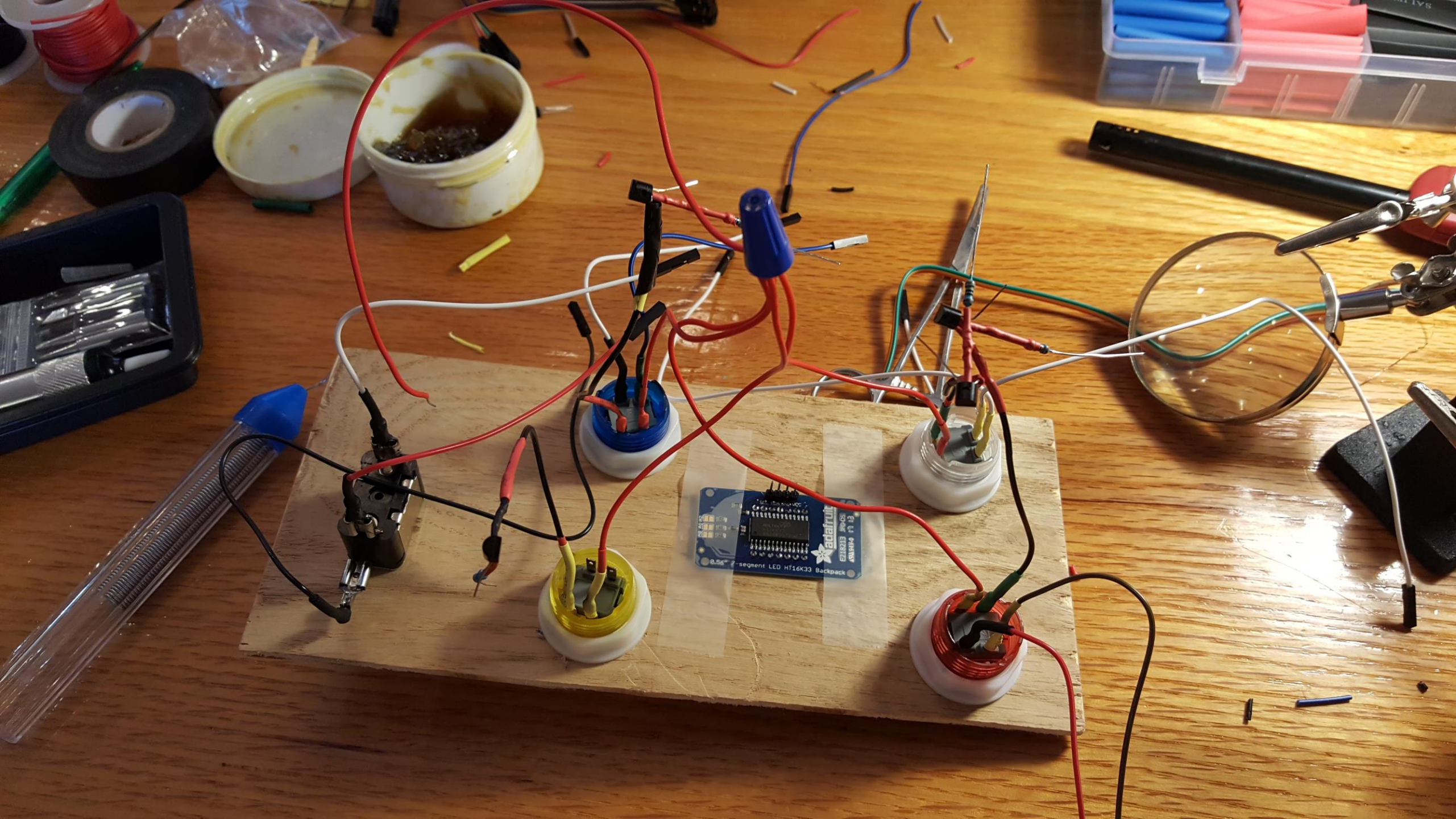
NOW THE COOL STUFF…

- What could I do next?
- Bring Video Game to Life

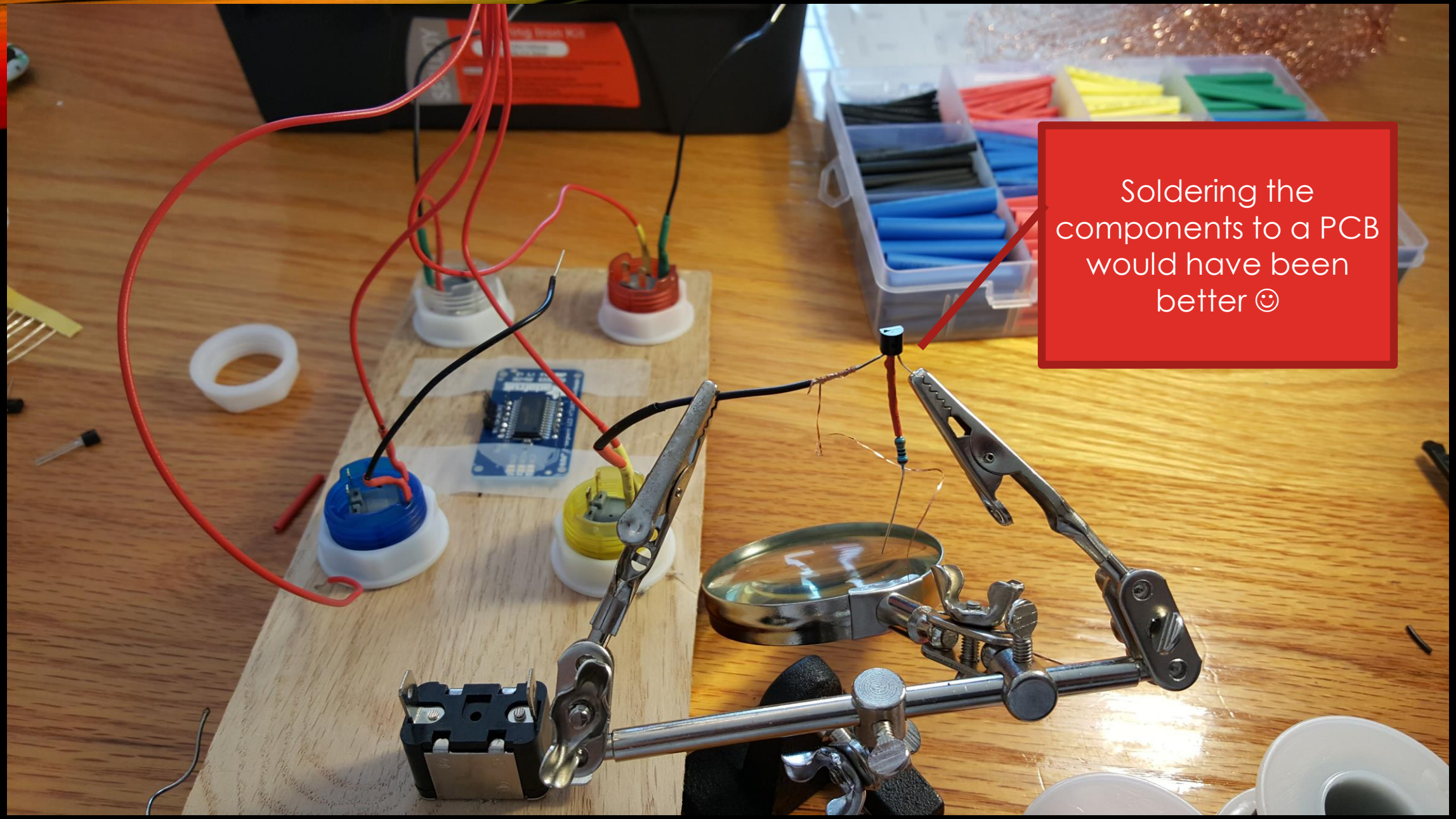


Pi Bomb

BOMB CONSTRUCTION


0.56" 4-segment LED HT16K33 Backpack
adafruit


02:13
White
Blue
Yellow
N/A
Master Switch


Soldering the components to a PCB would have been better ☺

Game Commander links

- Demo of it working:
- https://www.youtube.com/watch?v=NPXPuUTFG04

- Source Code for Timers:
- https://github.com/javaplus/pi_timer_python

- Source Code for Servers REST endpoint:
- https://github.com/javaplus/timer_controller

- Source Code for Pi Bomb:
- https://github.com/javaplus/pi_bomb_game

PARTS

- 7 Segment Display:
- https://www.adafruit.com/product/1270
- https://chicagodist.com/products/adafruit-1-2-4-digit-7-segment-display-w-i2c-backpack-red
- Sound Card for Pi Zero:
- SYBA external USB Stereo Sound Adapter for Windows, Mac, Linux Extra Audio Source with Microphone SD-CM-UAUD
- USB Speakers:
- SUPVIN Portable Mini Clip-On USB Powered Stereo Multimedia Speaker Soundbar for Notebook Laptop PC Desktop Tablet Black
- Battery Backup To Power Pi:
- Aibocn Power Bank 10,000mAh External Battery Charger with Flashlight for Apple Phone iPad Samsung Galaxy Smartphones Tablet
- 3.5mm Male & Female Gold Banana Plug Bullet Connector:
- https://www.amazon.com/dp/B073XRDKRH/ref=dp_cerb_1

INTERACTIVE (EXPLODING) BIRTHDAY CAKE

- Wanted to create Interactive cake that would blast whip cream everywhere.

- Parts:

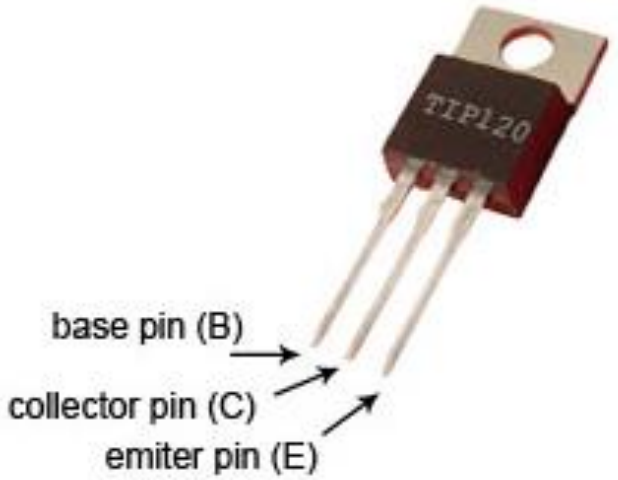
- Uses Piezo Film sensor for “hit” detection
- 7 Segment display
- 12V Solenoid (default closed) 100PSI rating
- TIP 120 Darlington transistor
- Resistors
- LED’s
- CAKE!

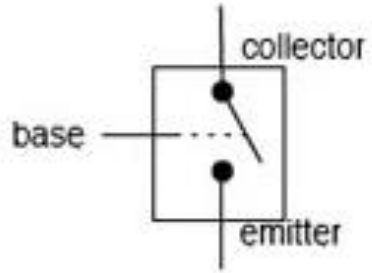
BUILDING THE EXPLODING CAKE

- Video Overview and Actual Use at Birthday Party
- https://www.youtube.com/watch?v=6N5fufapHn0
- ..\Videos\BirthdayCakeWhipCremeShot.mp4

TRANSISTORS AS SWITCHES

- Just works as a switch with no moving parts
- Alternatives:
  - A relay could be used as well, but it uses power(electricity) to switch a physical switch.
  - Most relays can be used with AC as well





It works like a switch

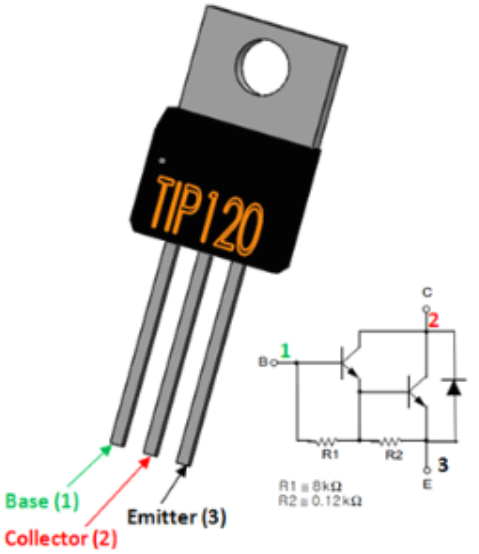
TRANSISTORS AS SWITCHES

- Great for controlling higher voltage items like motors or solenoids.
- Pi can only control 3.3 volts typically. Arduino has 5V output usually.

TIP120 – Darlington NPN Transistor

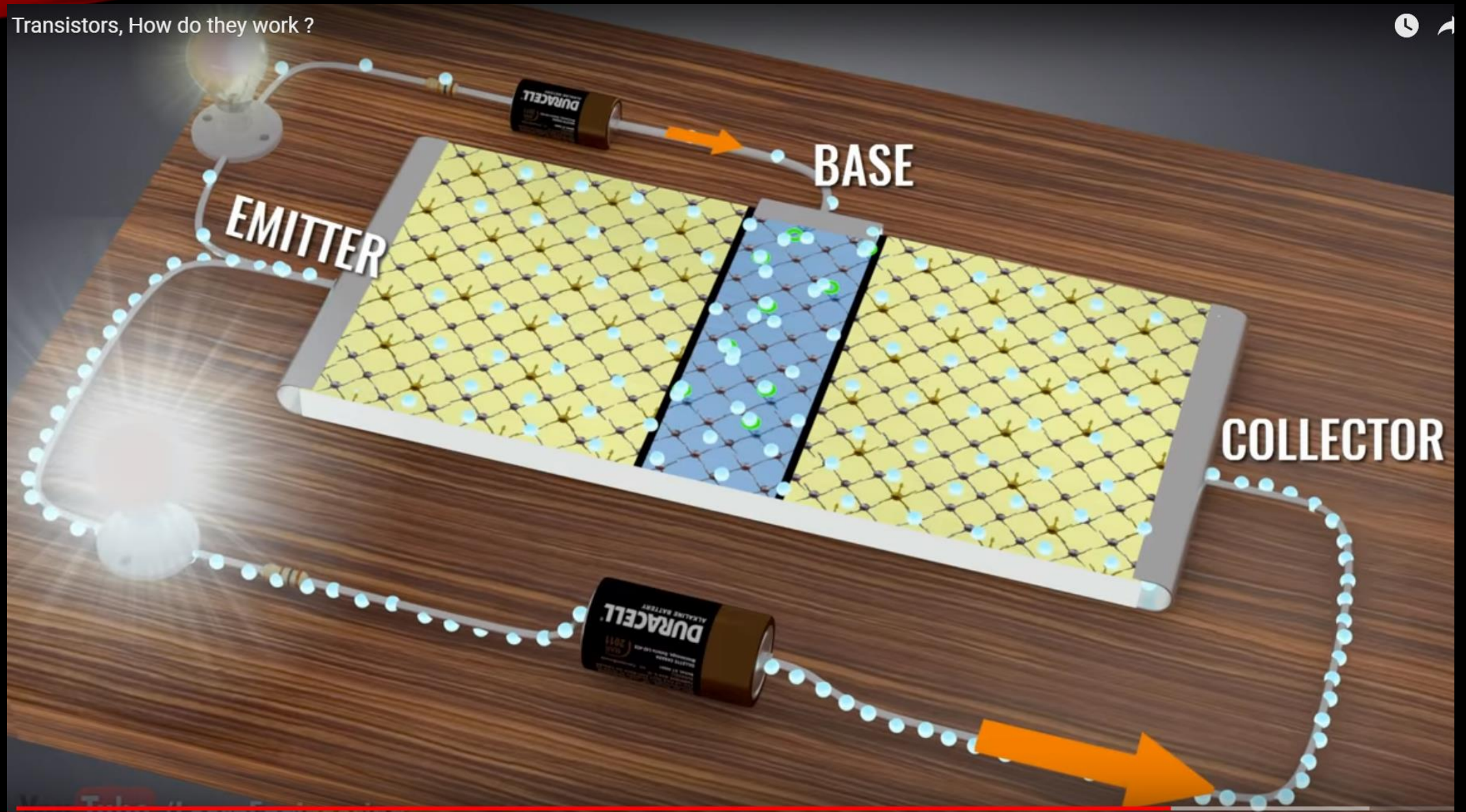
8 January 2019 - 0 Comments

TIP120 Transistor



TIP120 Pinout

TRANSISTORS AS SWITCHES



TRANSISTOR LINKS

- How transistors work video:
- https://www.youtube.com/watch?v=7ukDKVHnac4
- Arduino Tutorial with the TIP 120 Darlington Transistor:
- https://www.arduino.cc/en/Tutorial/TransistorMotorControl
- Pin out and schematic of TIP 120 Transistor:
- https://components101.com/transistors/tip120-pinout-datasheet-equivalent
- Controlling a solenoid with an Arduino
- https://core-electronics.com.au/tutorials/solenoid-control-with-arduino.html
- http://www.martyncurrey.com/controlling-a-solenoid-valve-from-an-arduino/

LESSONS LEARNED

I am now Less Dumb than I used to be!

LESSON'S LEARNED

Public Service Announcement

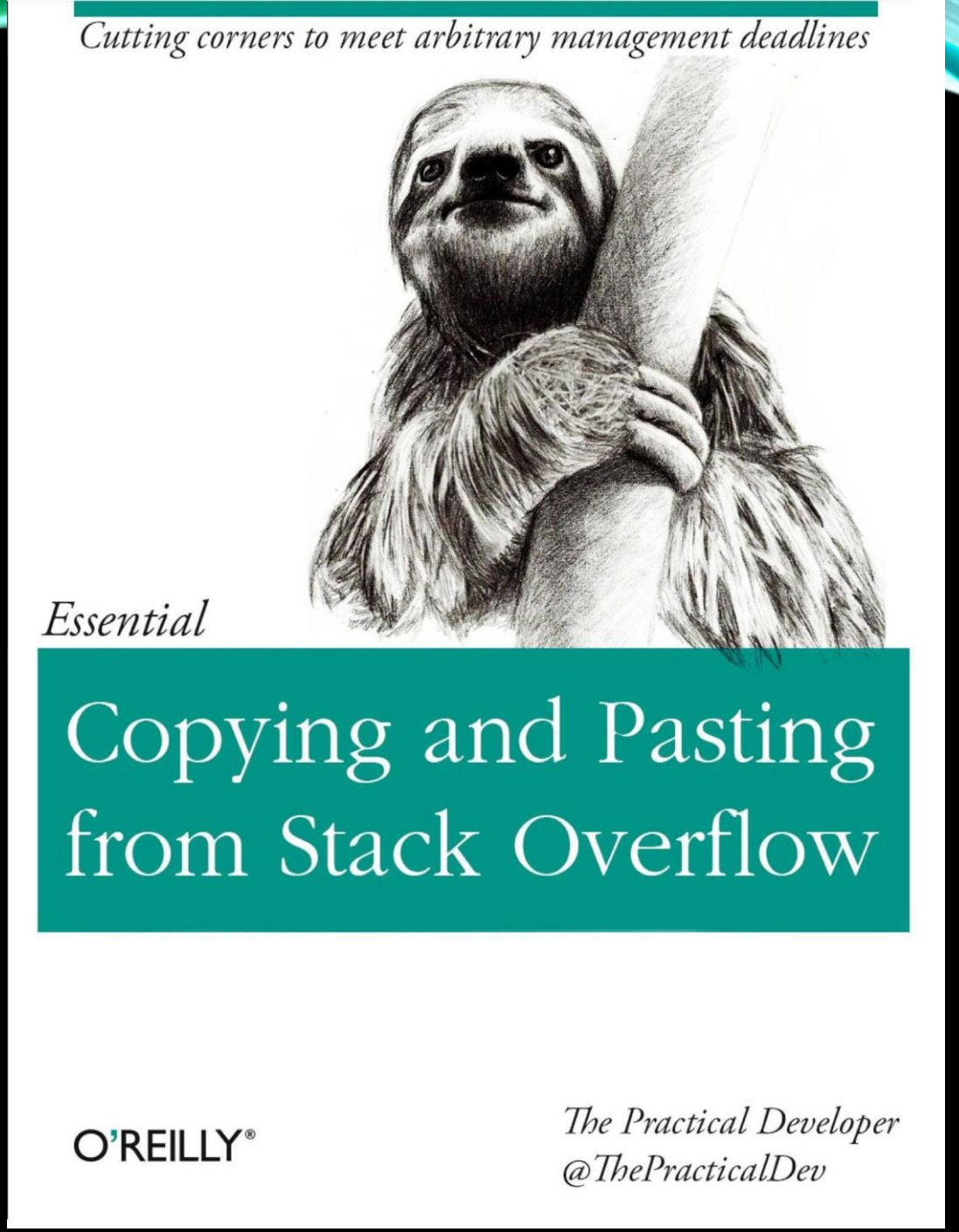
How To Not Do Stupid Thing

PYTHON IS BEST SUITED FOR MOST PI PROJECTS

- Most libraries for after market parts like Adafruits add-ons have Python libraries to make it easy to use them and examples…
- Many Python Libraries for the Pi (like Adafruit libraries) rely on Python C extensions and Jython does not seem to support that.
- Not as many resources for using other Languages.

THINGS CHANGE… WHERE TO FIND HELP

- Things change so fast, the first answer you find may not be new enough.
- Library or OS you are using may be different than the tutorial you are reading.



USE THE SOURCE

- Use GitHub issues
- Look at the Source Code
  - Examples
  - API's
  - Configuration options

- Commit your own code to somewhere! GitHub, GitLab, etc..

HOW TO DO GITHUB
(the absolute basics)

DOCUMENT IN README.MD

README.md

motor_mobile

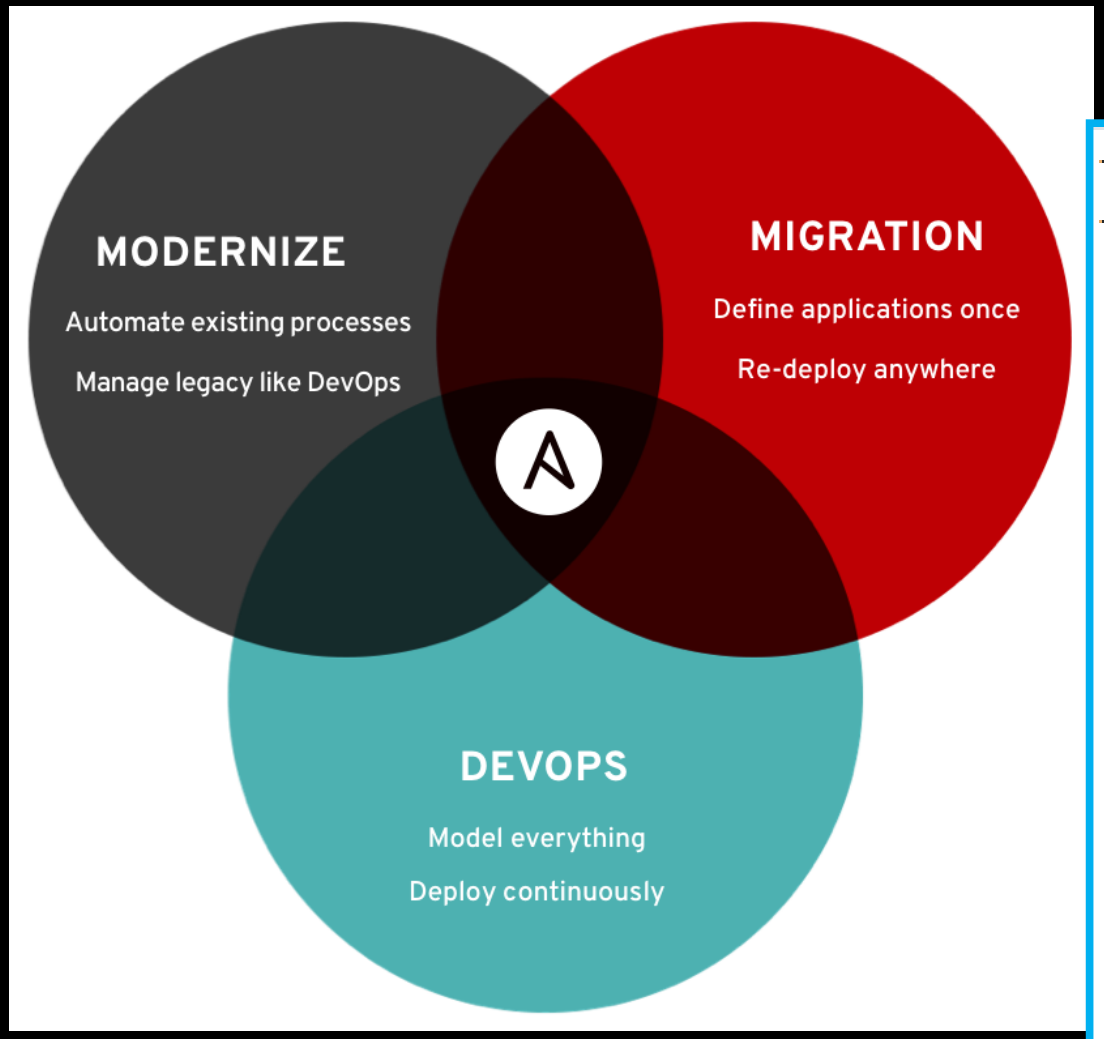
How to package to mobile:

https://ionicframework.com/docs/intro/deploying/

ionic cordova build android --prod --release

jarsigner -verbose -sigalg SHA1withRSA -digestalg SHA1 -keystore c:\devl\androidSDK\keys\my-release-key.jks app-release-unsigned.apk my-alias

SCRIPT THE THINGS! ANSIBLE



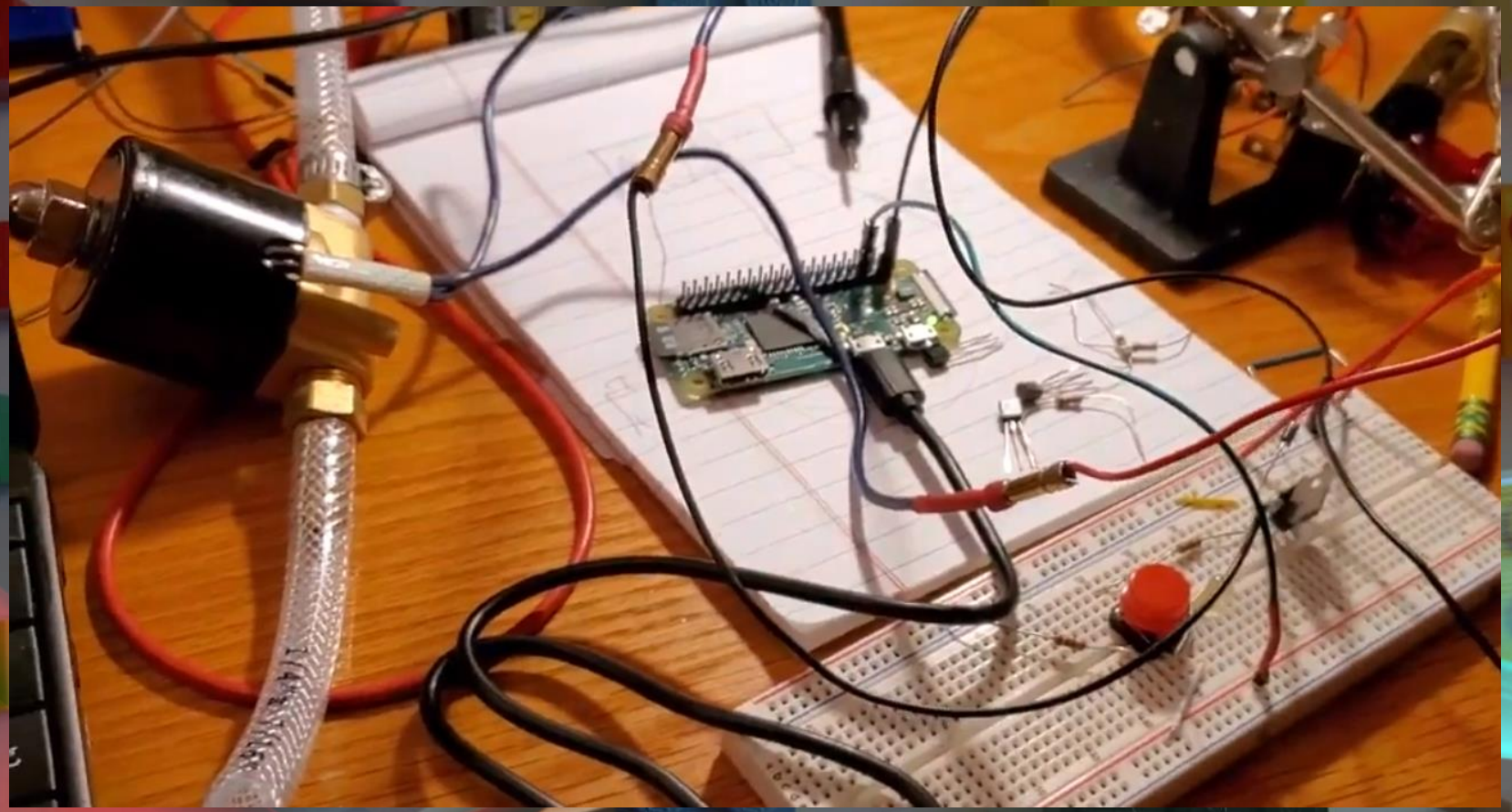
Ansible Recipe for NTP setup

```
---
- hosts: all
  become: true
  tasks:
    - name: update packages
      apt: update_cache=yes

    - name: Install ntp
      apt: name=ntp state=latest

    # replace config file for NTP
    - name: set up ntp config file
      copy: src=./ntp.conf dest=/etc/ntp.conf owner=root group=root mode

    - name: update rc.local to get latest date
      lineinfile: path=/etc/rc.local insertbefore='exit 0' line='sudo se
```

THINGS I WISHED I'D DONE OR KNOWN

- Centralized Logging
- With distributed, headless projects centralized logs to capture errors would aide in troubleshooting.

Break things down into smallest components to test and learn.



VOLT METER

- Get a Volt Meter and learn to use it… great for testing diodes (LED) and even transistors and just if pins are turning on and off like you expect.

WALK AWAY

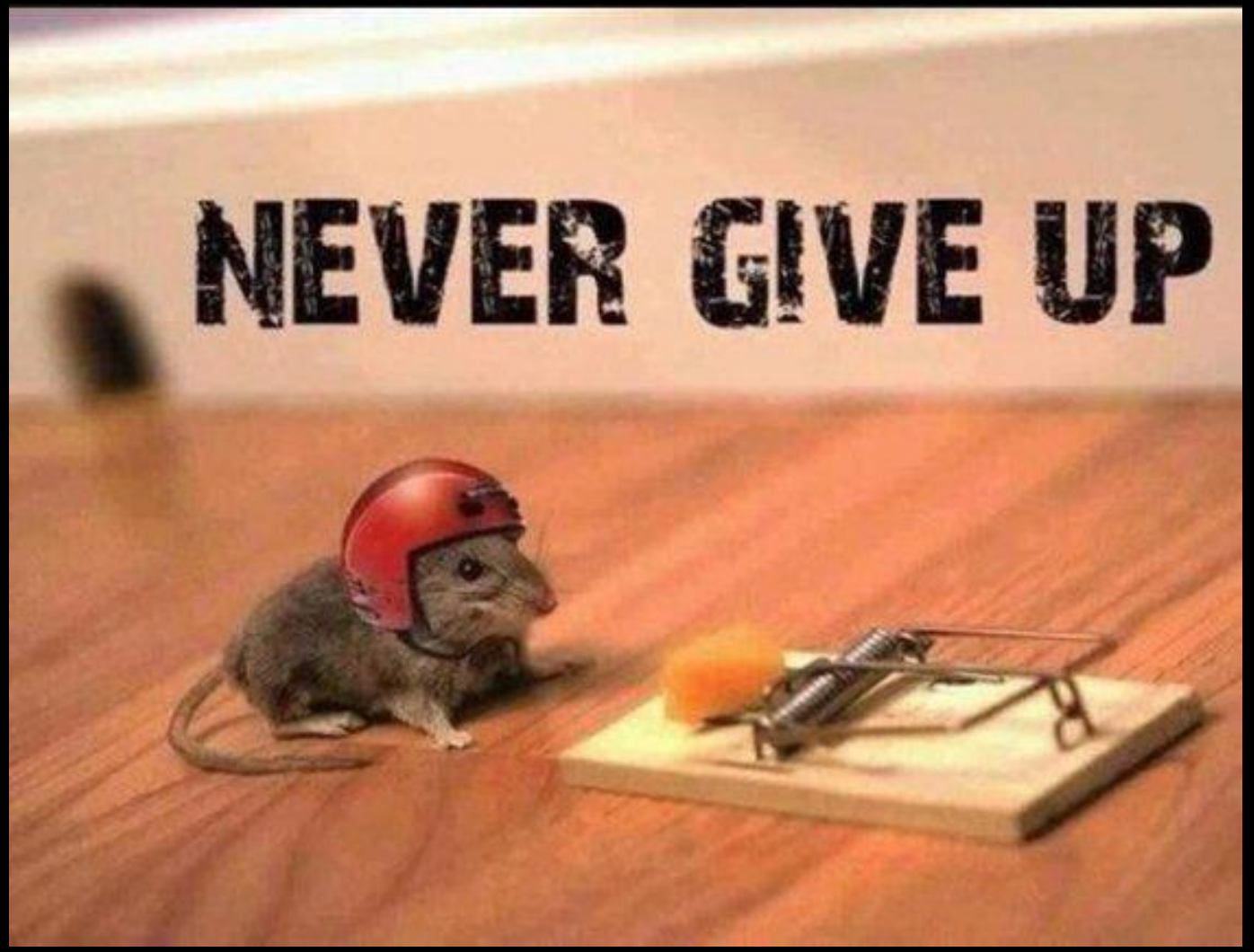
- Walk away.
- Get a different perspective.
- Rethink the problem.

USEFUL TIPS

- Prioritize
- (Keep Focused)

DON'T GIVE UP!

- Progression of Exploding Cake
- https://www.youtube.com/watch?v=q4e7Mgnnl2k&t=7s



Your Adventure Awaits!

QUESTIONS?

- Come visit the Nationwide Booth near the concession area for an up close look or for more questions.

- Contact me: btarlton@gmail.com