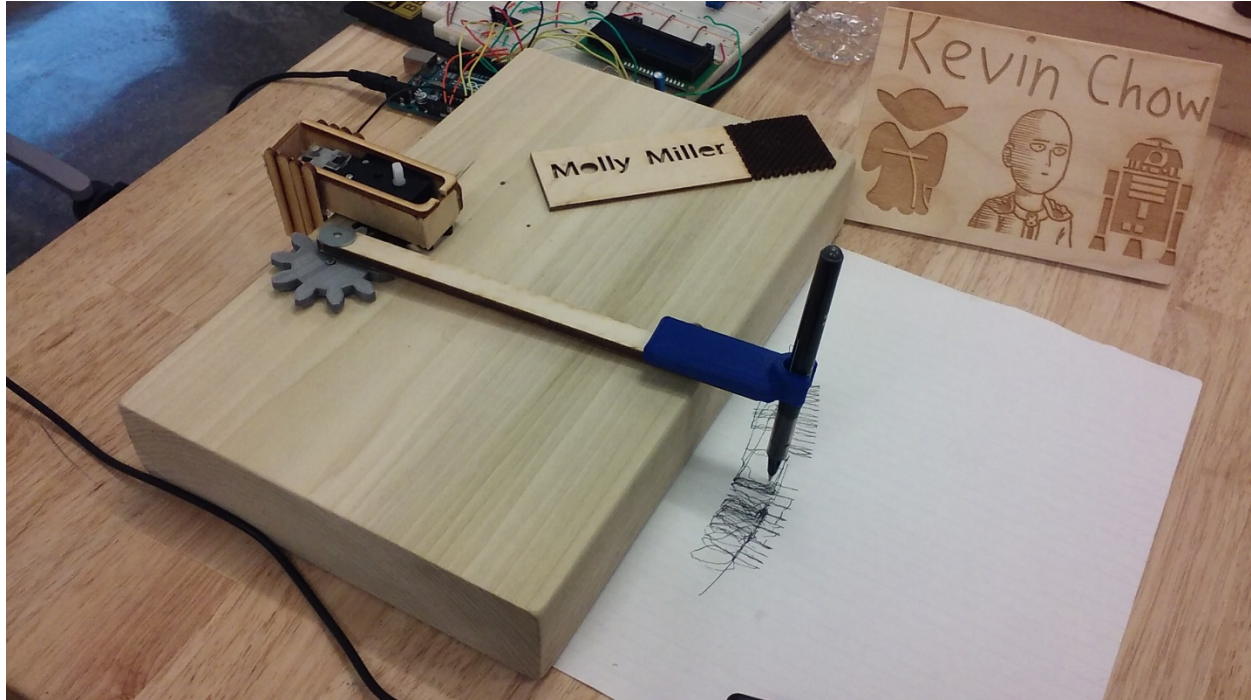


## Drawing Machine Final



Our final drawing machine, like the previous version, had a simplistic structure, as it only used two gears: one that is run by the motor and one that moves the arm that holds the drawing pen. This final drawing machine draws random-looking marks on the paper while accompanied by random musical tones and text display on an LCD screen (that displays the direction that the motor is spinning if it is spinning or indicates that the motor has stopped moving if stop button was pressed). There are three push-button switches for controlling the machine: one button for making the motor go in one direction, another button for making the motor go in the opposite direction, and one last button for stopping the motors. Unlike the previous version of our drawing machine, in this version, the motor will keep on rotating until the user presses the stop button. The user no longer needs to be constantly holding down the button for the machine to work.

### Bill of Materials:

The materials we used in our final submission for this part of the project (that means not including the materials we used along the way but did not end up keeping in our final submission) include the following:

- 1 block of poplar wood (12'' long, 6'' wide, 2'' thick)
- 1 Arduino Uno
- Several jumper wires

- 1 large breadboard
- 1 piezo buzzer
- 1 H-bridge (L293D)
- 3 push-button switches
- 3 10k ohm resistors
- 1 220 ohm resistor
- 1 DC motor
- Laser-cut pieces to hold the motor
- Laser-cut piece to serve as the drawing machine's "arm"
- 1 3D printed pen holder
- 1 pen
- 1 3D printed gear
- 1 nail
- 1 washer
- 1 laser-cut gear
- 1 16 x 2 LCD display
- 1 potentiometer
- 1 100 microfarad capacitor

### **Process:**

Like our process during the previous iteration of our drawing machine, much of our process for this version involved experimenting with placements of gears. This involved much drilling and hammering to test out various placements of the gears. Along the way, we broke the stud part of most of the studded gears we 3D printed out. So we did not have many studded gears left by the end of the project despite having 3D printed out several. We also struggled with figuring out how to attach the gears to our wood without the gears being too wobbly, or too tight.

As for the electronics portion of the project, we somehow managed to resolve last week's issue with the attempted usage LCD screen and the issue of the H bridge not operating backwards. This time, I managed to get the wiring correct (though I'm not sure whether last week's problem with the LCD had anything to do with the wiring).



The wood we experimented on

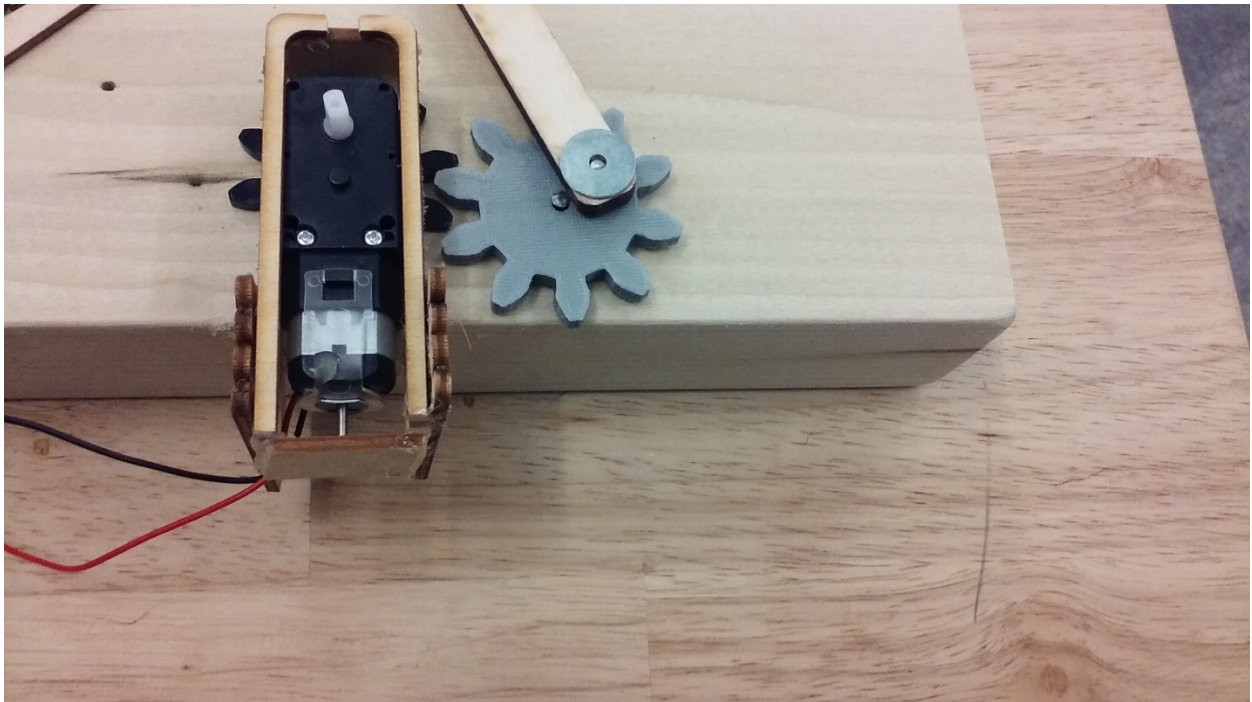


One of the many studded gears that we broke





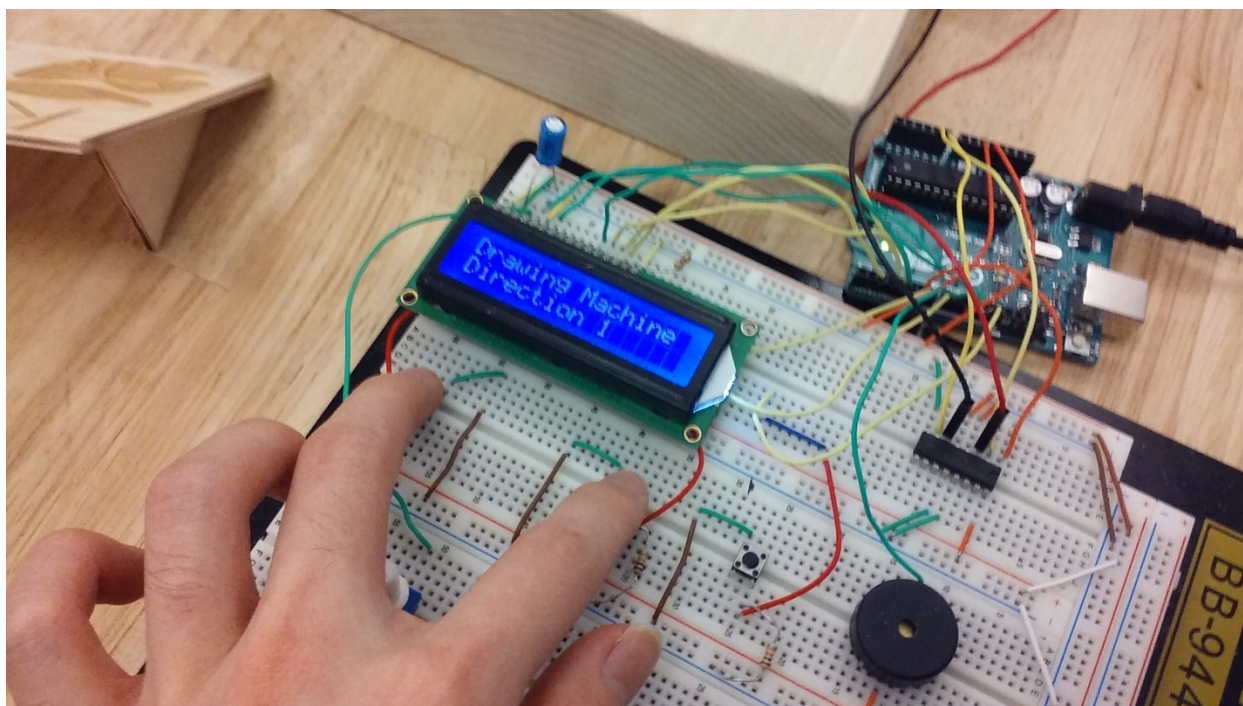
A 3D printed arm that we were planning on using for the machine, but decided not to use due to the arm being too short



Our motor with gears

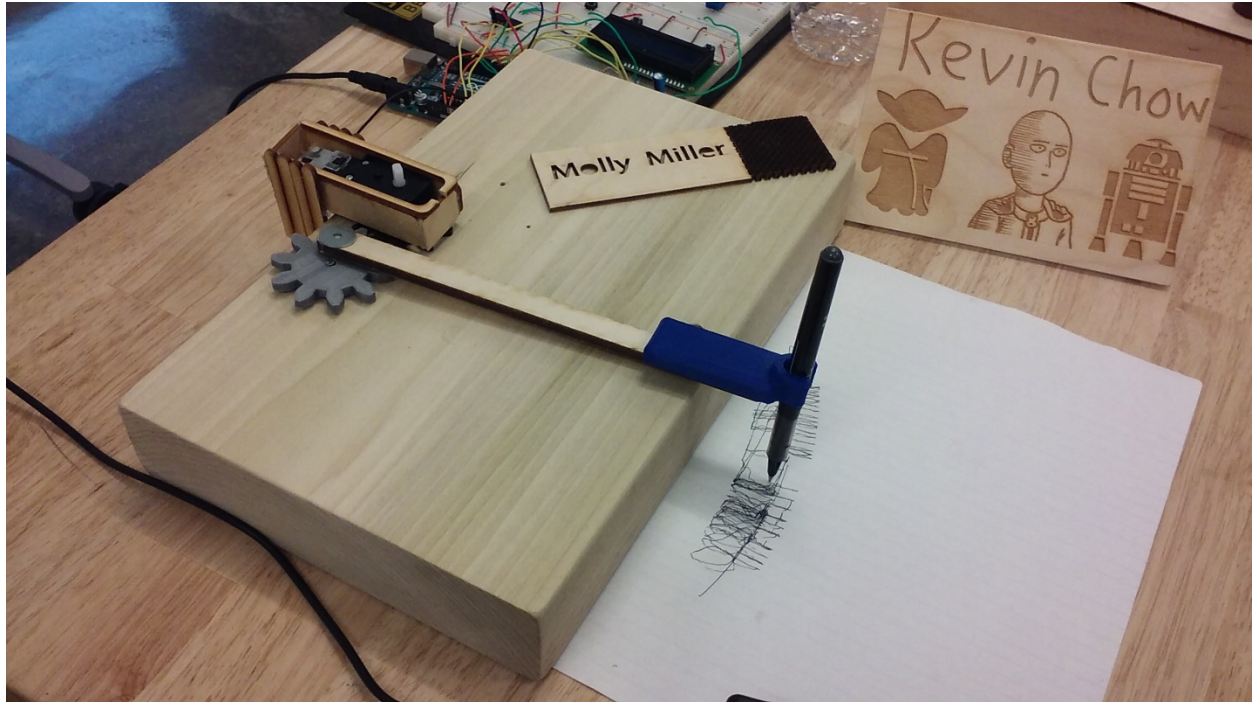


Our 3D printed arm

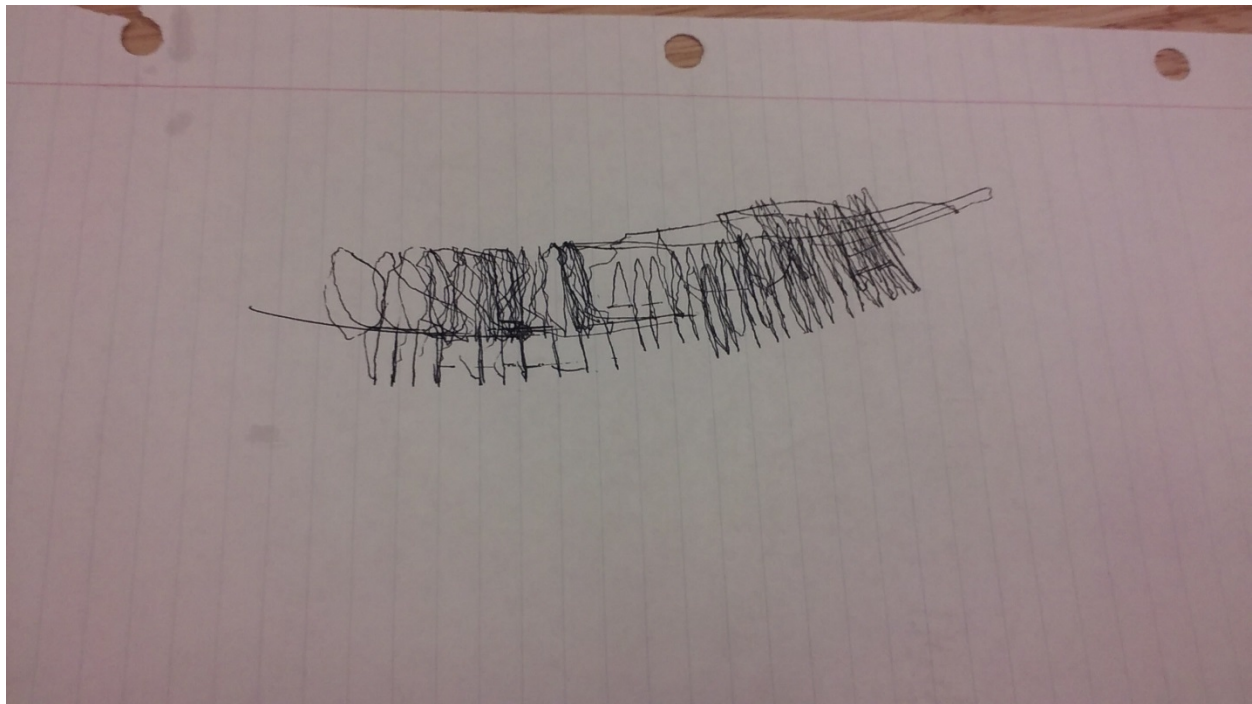


Our working LCD display



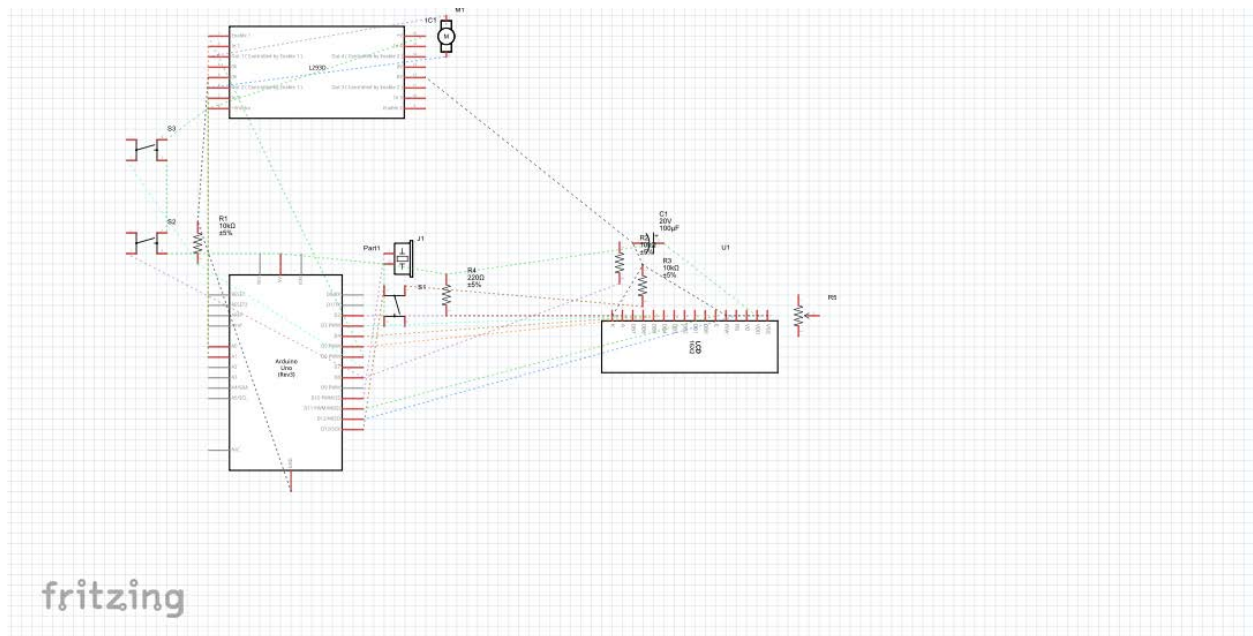
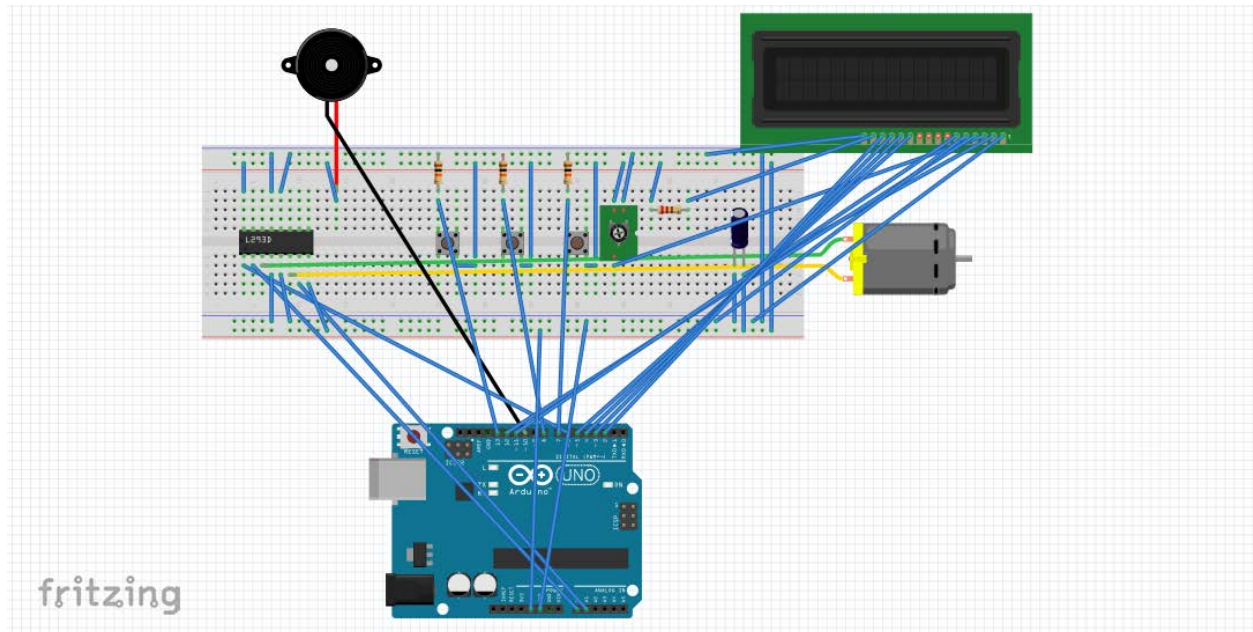


Our final drawing machine



The drawing that our final drawing machine can produce

## Circuit and Code:



```
#include <LiquidCrystal.h>

LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

const int motorPin1 = A0;
const int motorPin2 = A1;
const int enablePin = 6;

const int switchPin1 = 7;
const int switchPin2 = 8;
const int switchPin3 = 13;

const int piezoPin = 10;

bool stopped;

void setup()
{
  pinMode(motorPin1, OUTPUT);
  pinMode(motorPin2, OUTPUT);

  pinMode(switchPin1, INPUT);
  pinMode(switchPin2, INPUT);
  pinMode(switchPin3, INPUT);

  pinMode(piezoPin, OUTPUT);

  digitalWrite(enablePin, HIGH);

  lcd.begin(16, 2);
  lcd.print("Drawing Machine");

  //Before we start, we play a tune to indicate that the
  //machine had been powered on
  //The tune is the "5 tones" tune from the Close Encounters of the Third Kind movie
  tone(piezoPin, 587, 500);
  delay(500);
  tone(piezoPin, 659, 500);
  delay(500);
  tone(piezoPin, 523, 500);
  delay(1000);
  tone(piezoPin, 294, 500);
  delay(500);
  tone(piezoPin, 330, 500);
  delay(500);
```



```

    stopped = true;
}

void loop()
{
    //if the motor is moving, play a random note every 300 milliseconds
    if (!stopped && (millis() % 300 == 0))
    {
        tone(piezoPin, random(440, 1000), 300);
    }

    int switchPinState1 = digitalRead(switchPin1);
    int switchPinState2 = digitalRead(switchPin2);
    int switchPinState3 = digitalRead(switchPin3);

    //controlling the motors based on button presses
    //and updating lcd based on motor status
    if ((switchPinState1 == HIGH) && (switchPinState2 == LOW) && (switchPinState3 ==
LOW))
    {
        lcd.setCursor(0, 1);
        lcd.print("Direction 1");
        digitalWrite(motorPin1, LOW);
        digitalWrite(motorPin2, HIGH);
        stopped = false;
    }
    else if ((switchPinState1 == LOW) && (switchPinState2 == HIGH) && (switchPinState3
== LOW))
    {
        lcd.setCursor(0, 1);
        lcd.print("Direction 2");
        digitalWrite(motorPin1, HIGH);
        digitalWrite(motorPin2, LOW);
        stopped = false;
    }
    else if ((switchPinState1 == LOW) && (switchPinState2 == LOW) && (switchPinState3
== HIGH))
    {
        lcd.setCursor(0, 1);
        lcd.print("Stopped    ");
        digitalWrite(motorPin1, LOW);
        digitalWrite(motorPin2, LOW);
        stopped = true;
    }
}

```

**Final Thoughts:**

As before, this revision of the drawing machine project was quite nerve-racking, as we spent 90% of the time figuring out how to place/attach the components onto our machine without parts getting stuck upon rotation. But at least our machine managed to function, if not in the best manner.

**Issues:**

Issues were discussed in the Process section above.

**Future Version:**

This is the final version of the drawing machine, so there will be no future version. However, if we had decided to go even further with revising our machine, we would probably have redesigned the gears so that the studs on them had a lower chance of breaking.