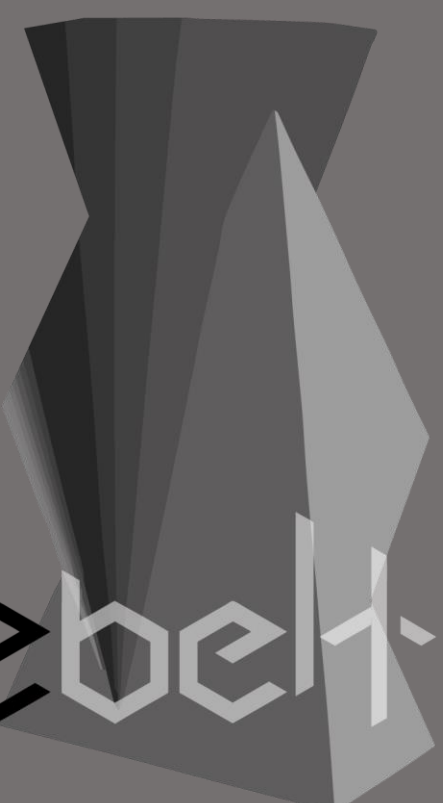# MAKER MANUAL

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spacebelt

ABOUT THE PROJECT:

Our final product consists of a flex sensor and a force-sensitive resistor (FSR) as inputs and an RGBW LED strip as the output. The flex sensor is placed along the section of the shoe which covers the middle of the foot up to the toe while the FSR is placed on the heel of the shoe. The flex sensor was placed here as this is where the foot bends the most, and the FSR was placed at the toe as to not so that while the dancer is using it, but can be tapped by the user as to not exert force that could be gauged as damaging. While pressure on the heel is applied, the LED strip lights up in different sequences and when the user bends their foot, which causes the flex sensor to bend, the brightness changes accordingly. The use and function of this shoe can be to communicate to other fellow dancers and give visual feedback of the dancer's feet movement in the form of various functionalities of the LED strip.
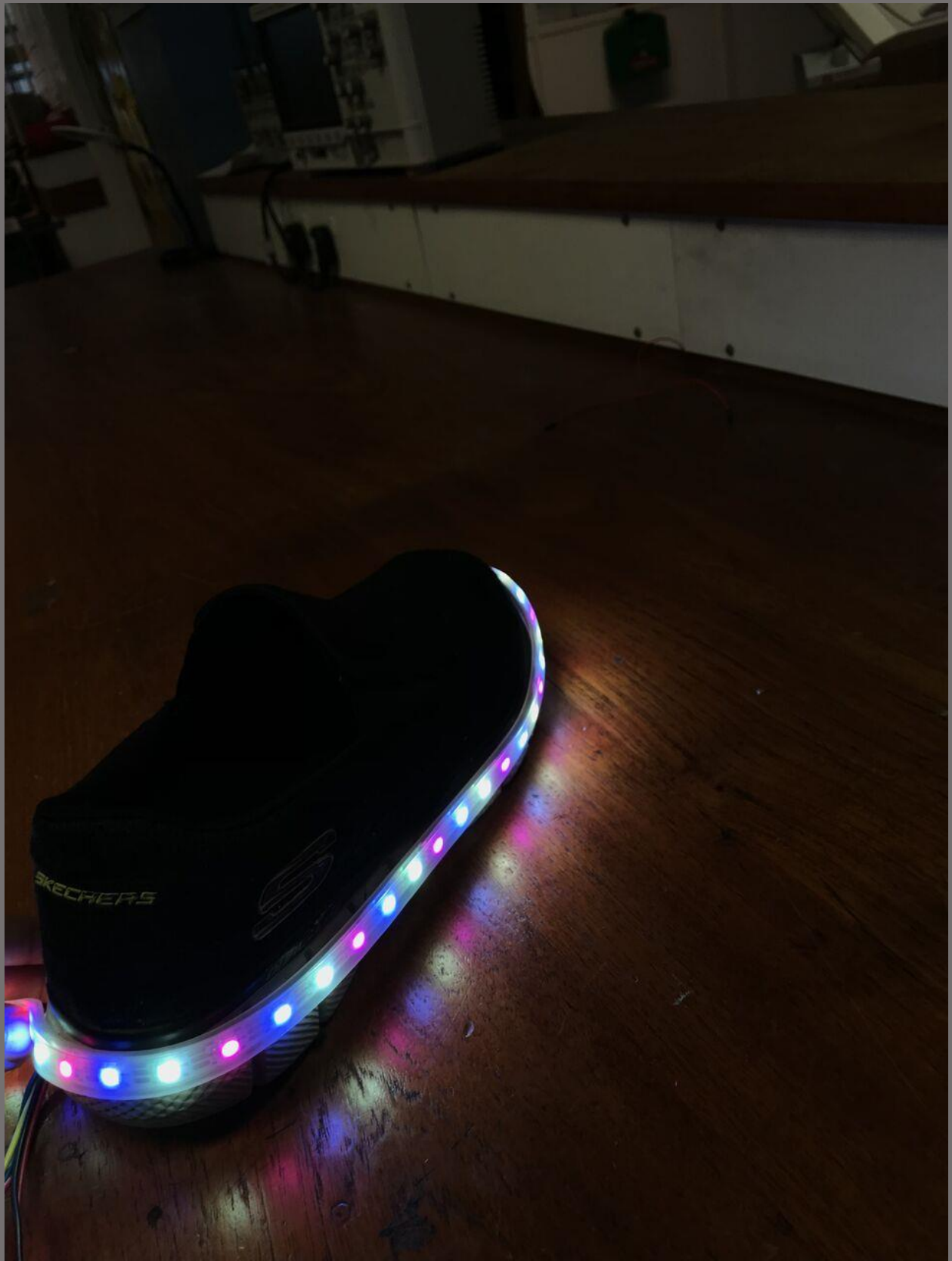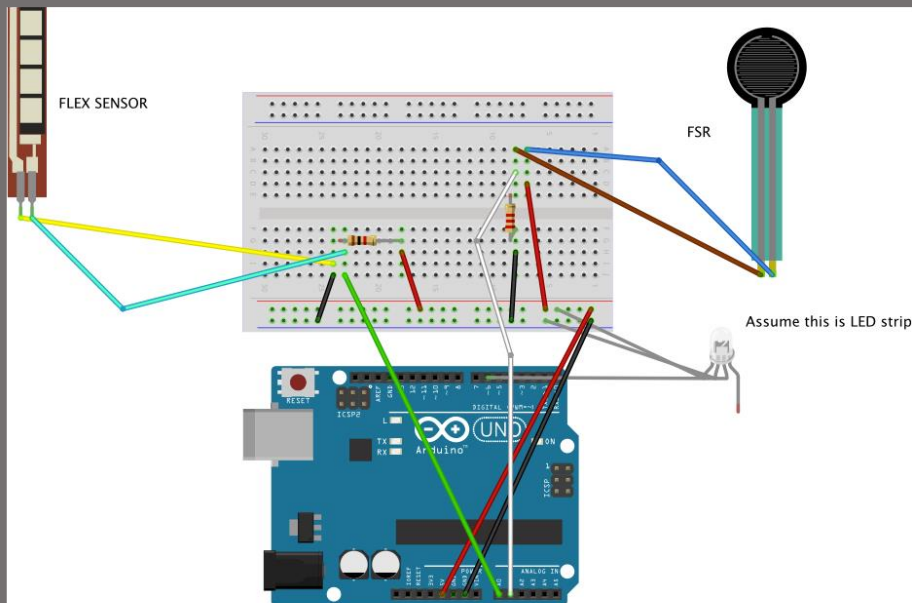
WHAT YOU NEED:

We did not use a ton of supplies as to be able to cater to inexperienced users. The only things you'll need are a: breadboard, Arduino Uno, flex sensor, FSR, LED strip, 2.2K **Ω** resistor, 1K **Ω** resistor, and connecting wires.

BREADBOARD LAYOUT:

This is a guideline to the connection of your circuit.

BUILDING PROCESS :

- Connect flex sensor and FSR onto the breadboard by soldering one end of the wire connector to the component leg and connecting the other end into the breadboard hole. (make sure the soldered wires are long enough to run from your shoe to your shin)

- Connect the rest of the components to the breadboard as shown in the layout in the previous section.

- Get a shoe (that you're willing to glue onto) and glue down the FSR onto the heel and the flex sensor on the bottom of the shoe tongue.

- Once completed, glue the LED strip around the shoe and cut it to the length of your desire.

- Strap the accompanied case holder around your leg and insert the Arduino and breadboard into it. (You may use a runner's phone case for this instead)

- Enjoy the light show and don't forget to stand out!

CODE :

```
#include<FastLED.h>
#define NUM_LEDS 60
CRGBArray<NUM_LEDS> leds;
const int FLEX_PIN = A0; // Pin connected to voltage divider output
const float VCC = 4.98; // Measured voltage of Ardunio 5V line
const float R_DIV = 47500.0; // Measured resistance of 3.3k resistor
const float STRAIGHT_RESISTANCE = 33000.0; // resistance when straight
const float BEND_RESISTANCE = 53000.0; // resistance at 90 deg
int fsrAnalogPin = A1; // FSR is connected to analog 0
int fsrReading;
int mapfsrVal;


void setup() {
Serial.begin(9600);
FastLED.addLeds<NEOPIXEL, 6>(leds, NUM_LEDS);
pinMode(FLEX_PIN, INPUT);
}


void loop() {
static uint8_t hue;
int flexADC = analogRead(FLEX_PIN);
float flexV = flexADC * VCC / 1023.0;// works out the voltage
float flexR = R_DIV * (VCC / flexV - 1.0);// work out resistance
fsrReading = analogRead(fsrAnalogPin);
mapfsrVal = map(fsrReading, 0, 1023, 0, 5);
float angle = map(flexR, STRAIGHT_RESISTANCE, BEND_RESISTANCE, 0, 255);
Serial.println(angle);
for (int i = 0; i < NUM_LEDS; i++) {
if ((mapfsrVal >= 1) && (flexR > 10)) {
```

```
// fade everything out
leds.fadeToBlackBy(0);
leds[i] = CHSV(hue++, 255, angle); // LED Strip on
FastLED.delay(3);
}
else {
for (int i = 0; i < NUM_LEDS; i++) {
// fade everything out
leds.fadeToBlackBy(0);
// let's set an led value
leds[i] = CHSV(0, 0, 0); // setting LED strip off
}
}
}
}
```

TESTING :

After settling on this final idea, multiple rounds of testing were conducted before the product was completed and presented. Before exploring the LED strip, we tested with a regular RGB led to make sure that the inputs were working as they should as we believed this was more important than the output.

Initially, we had the flex sensor change the RGB light when it was bent to a certain degree and the FSR changed the RGB LED to a different color when a certain amount of pressure was applied onto it. After figuring out that the input sensors worked as we wanted them to, we then began using the strip.

The strip we had ordered never arrived and so we were forced to borrow one from the electronics lab. After a couple of days of trying to get it to work, the lab technician concluded that the strip had a malfunction. We received a working strip one day before the project and commenced working on it. Being that our input sensors worked, all that was left was to get the strip to respond to the change in input sensors. We had the strip turn on when a specific amount of pressure was applied to the FSR and when the flex sensor was bent in the positive direction, the brightness would increment. A problem we faced with this is that when it was bent in the negative direction it would glitch and go between bright and dim. After testing the mechanism on a shoe and receiving positive results, we were ready to present the product. Aesthetically, the product was not well finished since the LED strip did not belong to us and so we were not able to glue it onto the shoe to give it a cleaner look. We had to use double-sided tape.

FURTHER DEVELOPMENT :

The product could be improved in three ways; the components should be embedded within the sole, the sensors could send data of the user's movements and the flex sensor resistor could change the pattern of the LED strips.

The LED strips should be embedded within the sole of the shoe so that they are less vulnerable and can be protected within the rubber of the sole. This means that we would have to take the sole off the shoe and carve out a line for the LED strip to fit into. We should order an Arduino Nano to fit into the sole of the as it is a lot smaller than the Arduino Uno. The Flex could have been in the sole, and therefore would measure the curvature within the sole. The FSR, however, would have to be in contact with the foot because if it was in the sole, it would not receive the full amount of pressure being applied to it.

A very important aspect of wearables, now, is the sharing of data and manipulating that. I think our project should incorporate this into it by uploading the degree of flex in the flex sensor. With the FSR, there are many options. A system that plotted the pressure applied to the FSR over the course of exercise would be interesting because you see when the user was fatigued and when they were most active. This would mean that the wearable could be used to analyse their movement across many different types of exercise rather than just dancing.

Currently the FSR only pauses or continues the light pattern on the LED. However, we think that the FSR should produce a pattern on the LED to show how much pressure has been applied to the shoe. For example, if a lot of pressure is applied the light can go red and if only a little then its blue. This will give the user instant feedback on how hard they are working out and could motivate users even more. In addition, the readings of the FSR could in some way be shared with fellow users of the product or other people in general.