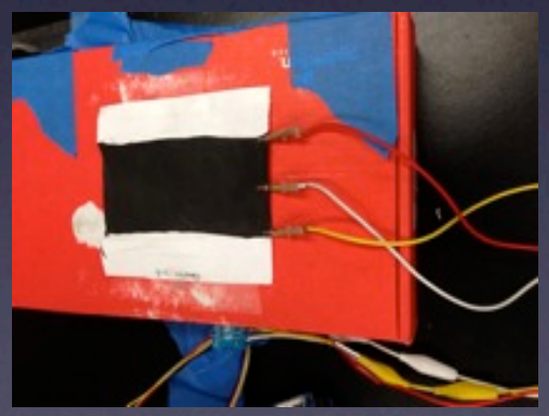
Exploring Open Source Technology In The Classroom

Little Bits

Graphite Potentiometer



CNC Autosampler

RET 2 Curriculum Project by Jesse Kasehagen
March 15, 2013

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Research Topic: Biosensors

Objective: To build a point-of-care device for a doctor's visit

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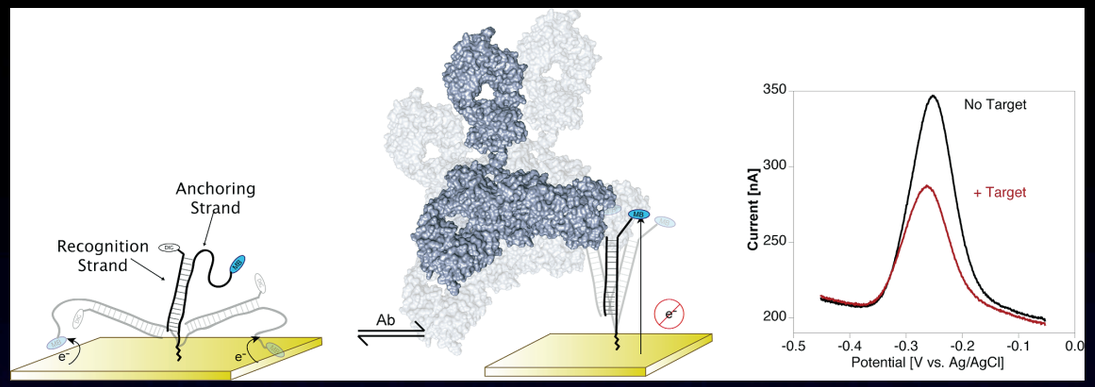

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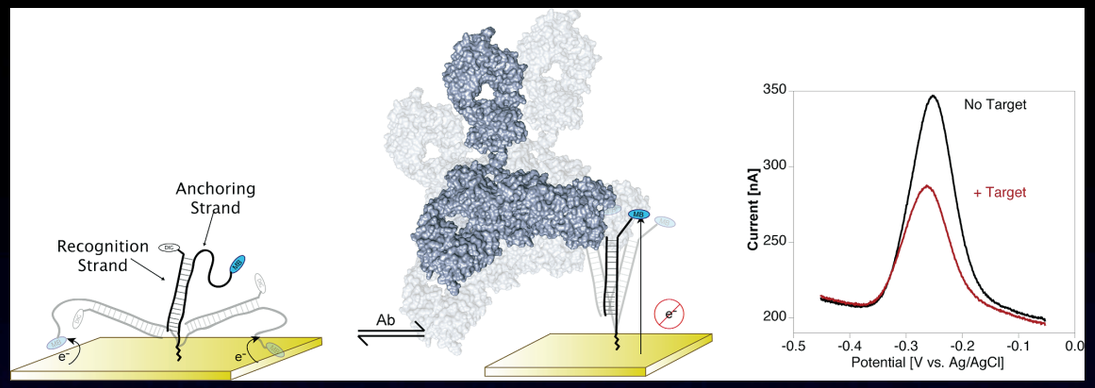

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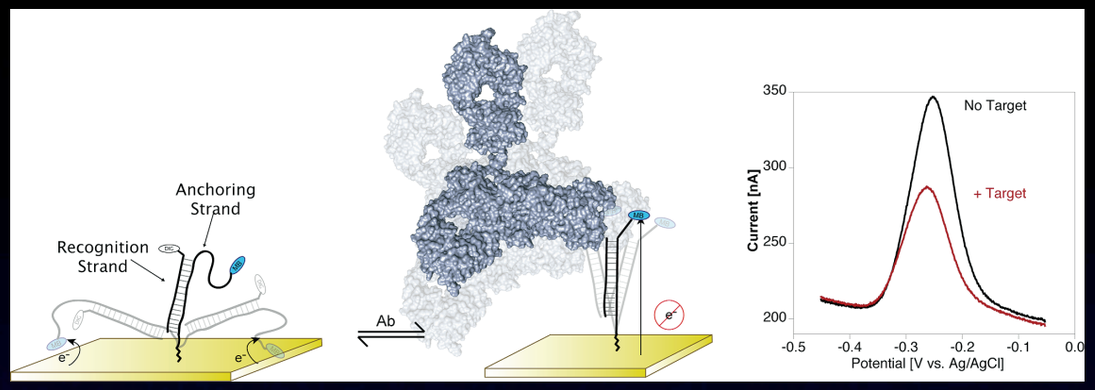

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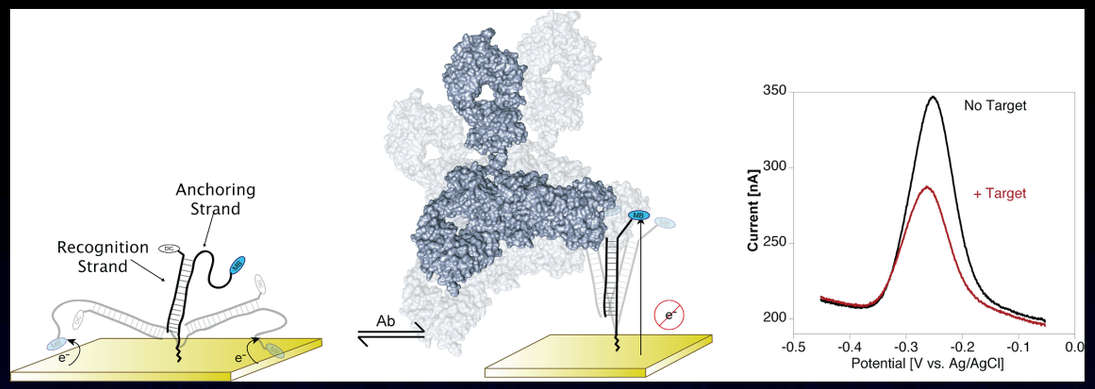

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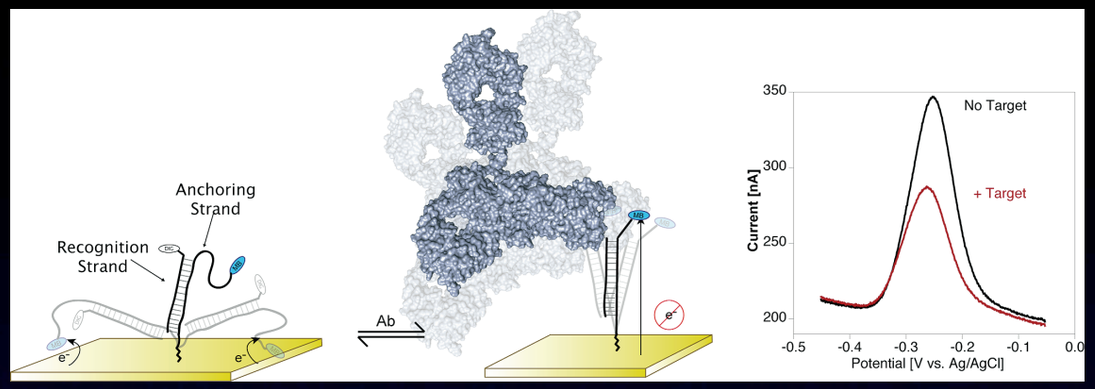

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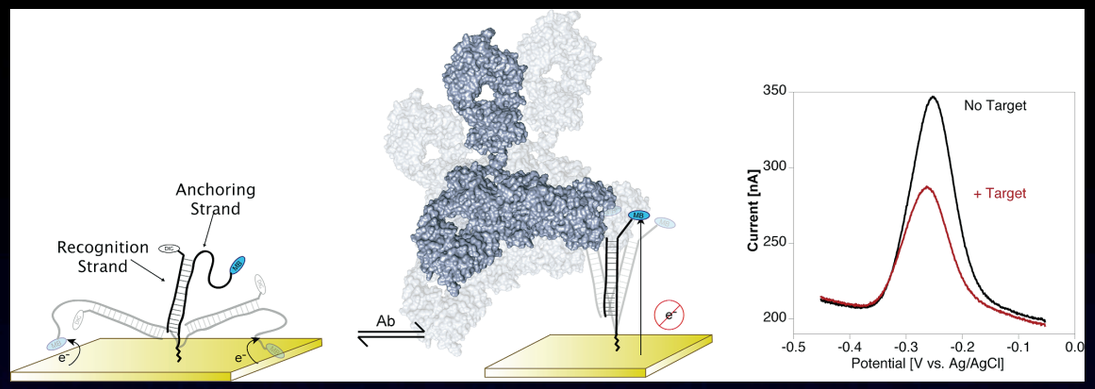

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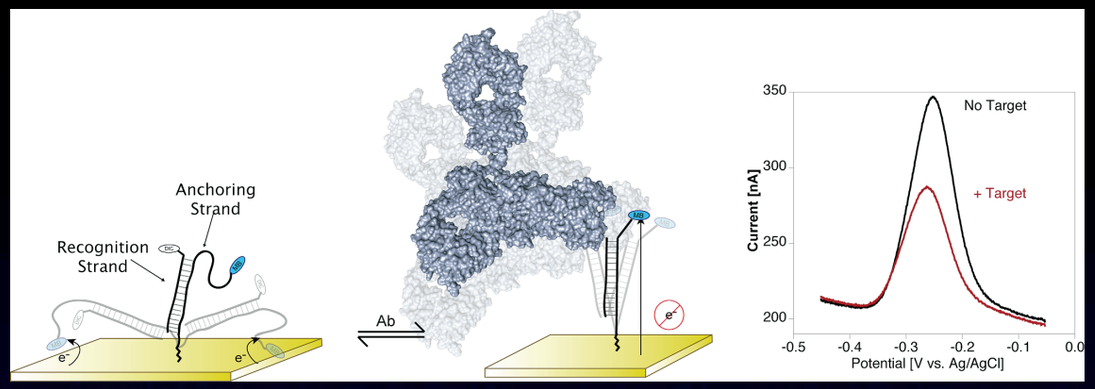

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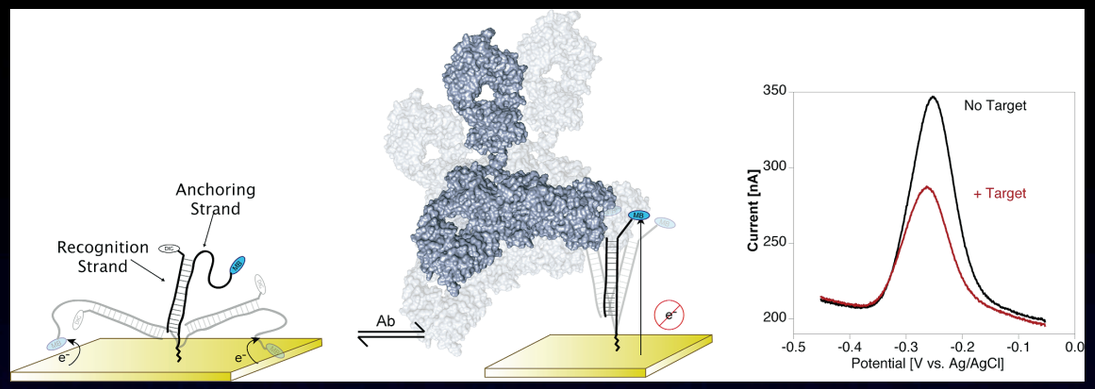

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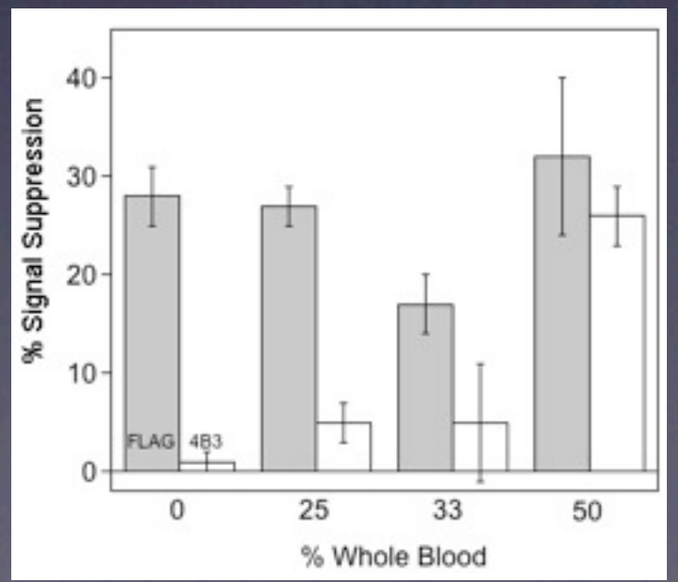

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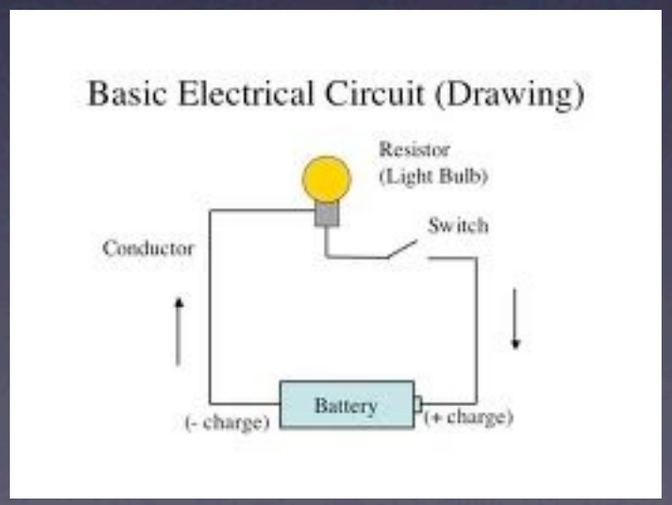

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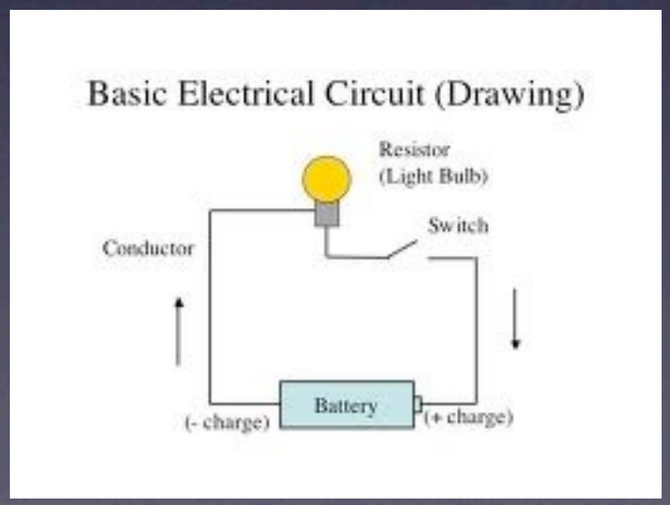

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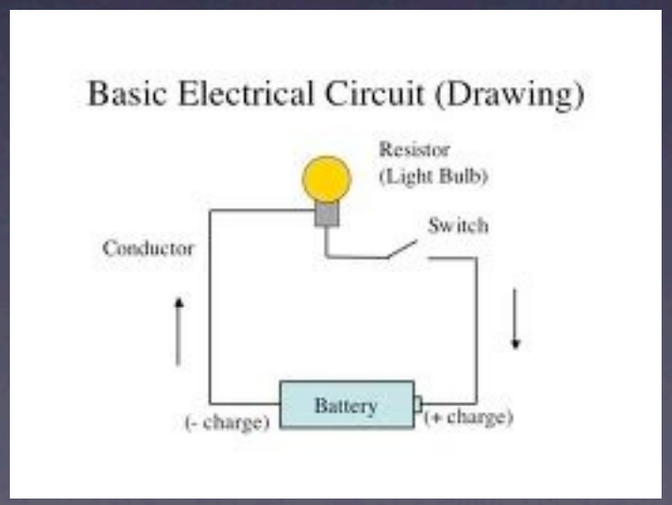

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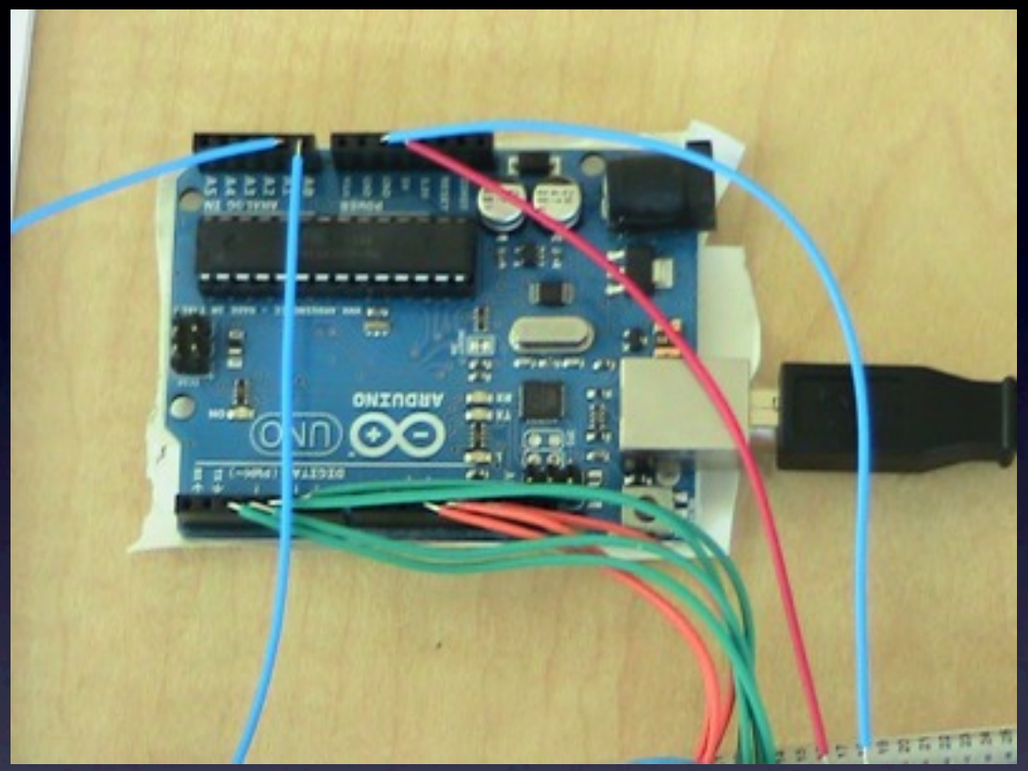

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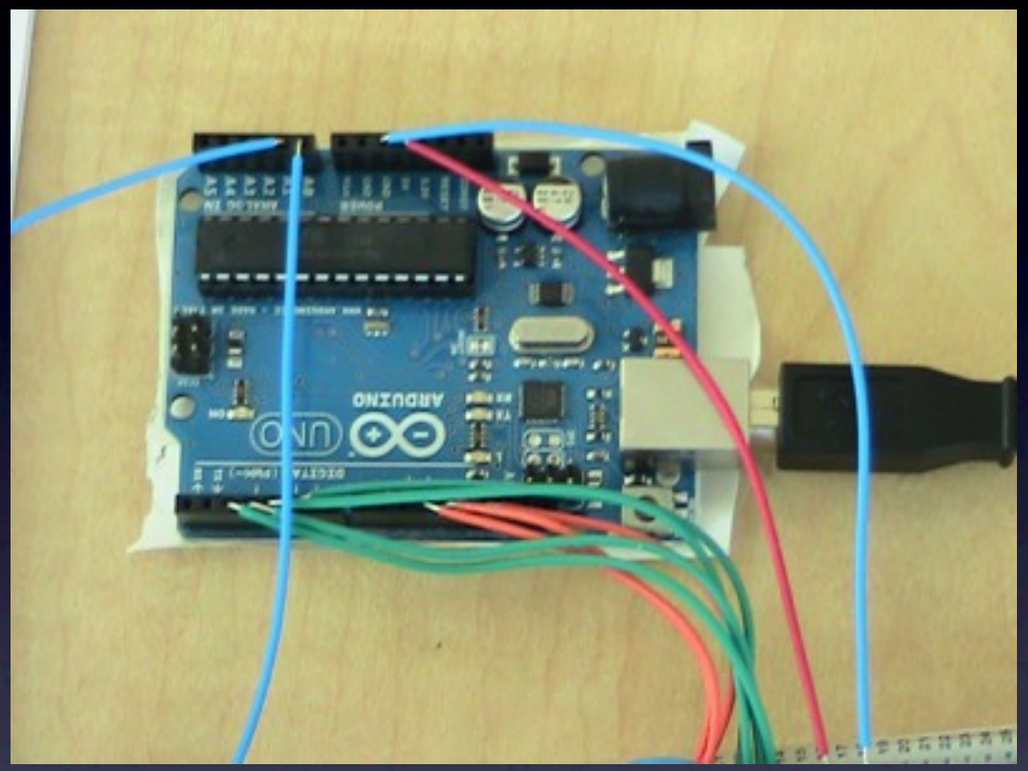

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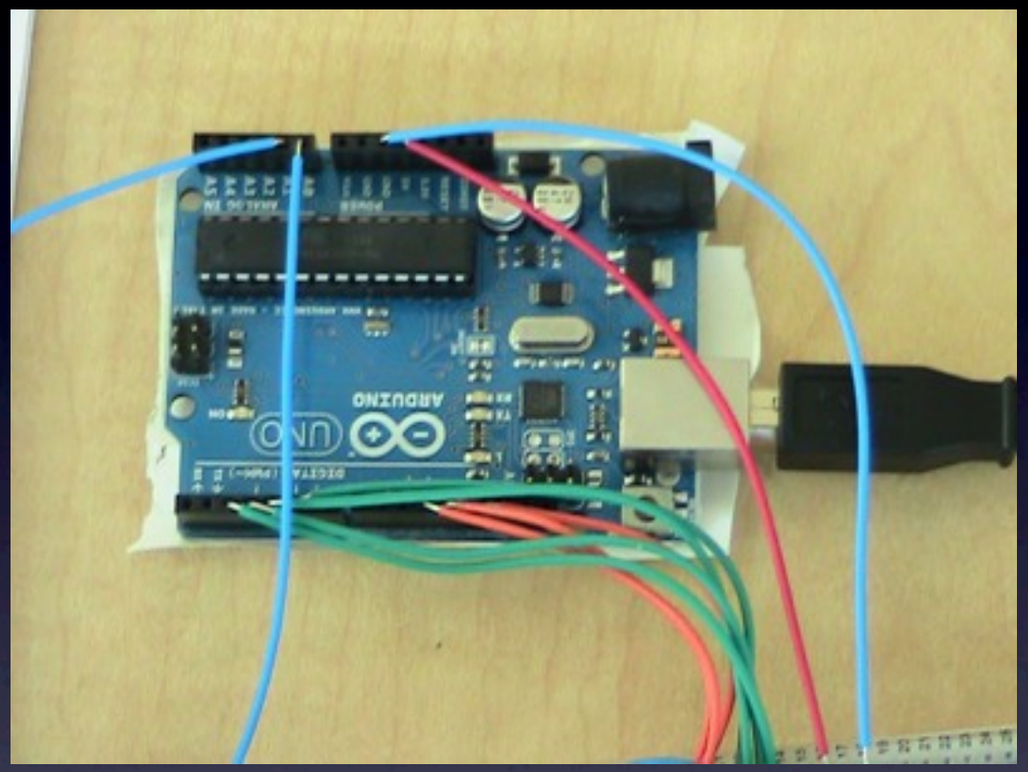

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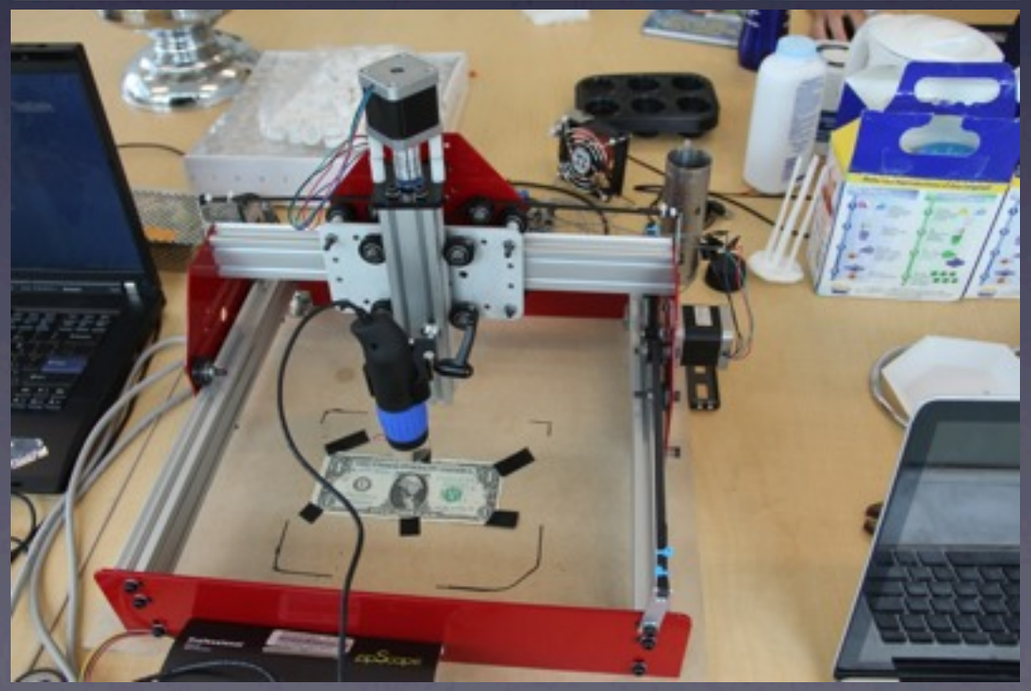

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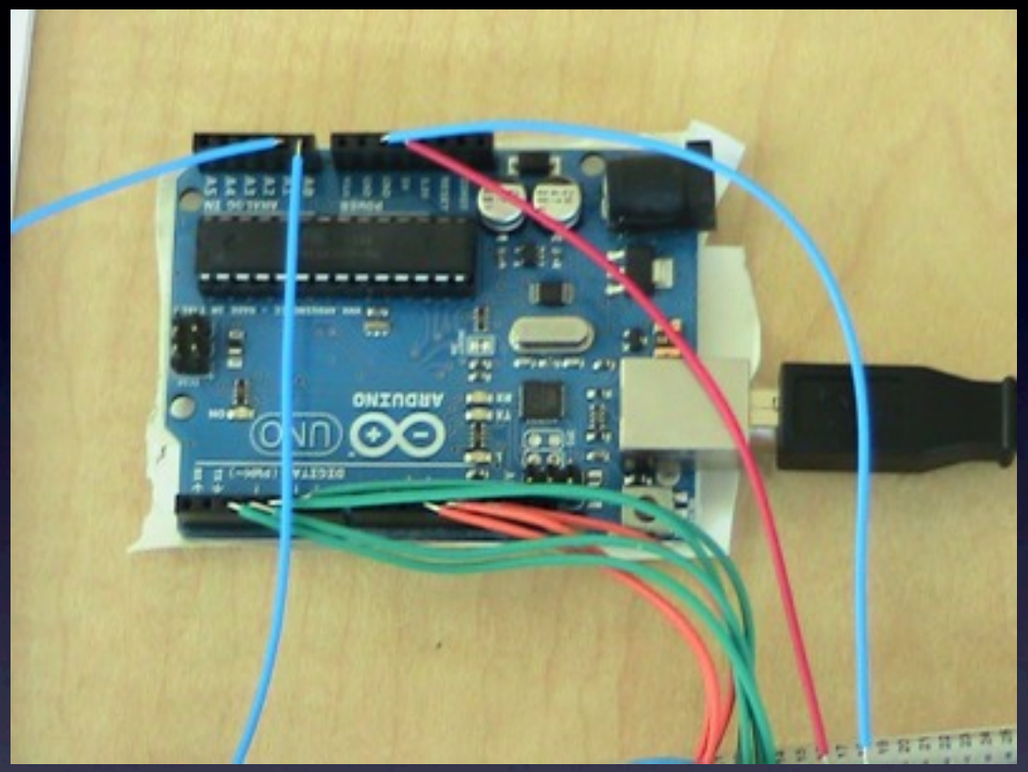

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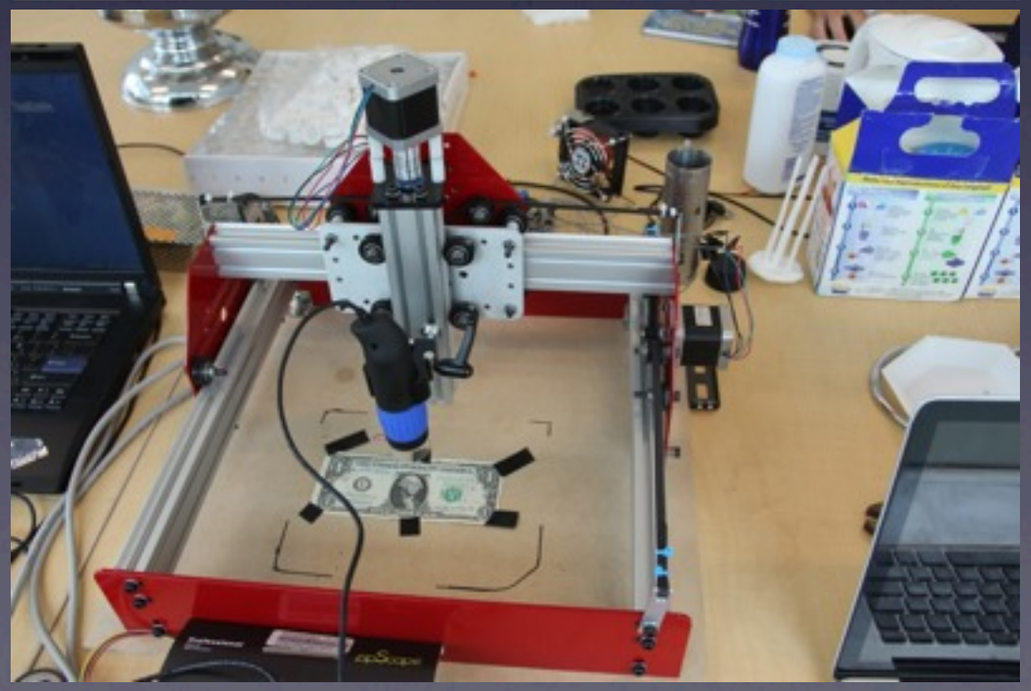
Built to run as a milling machine, explorative microscopy and autosampling



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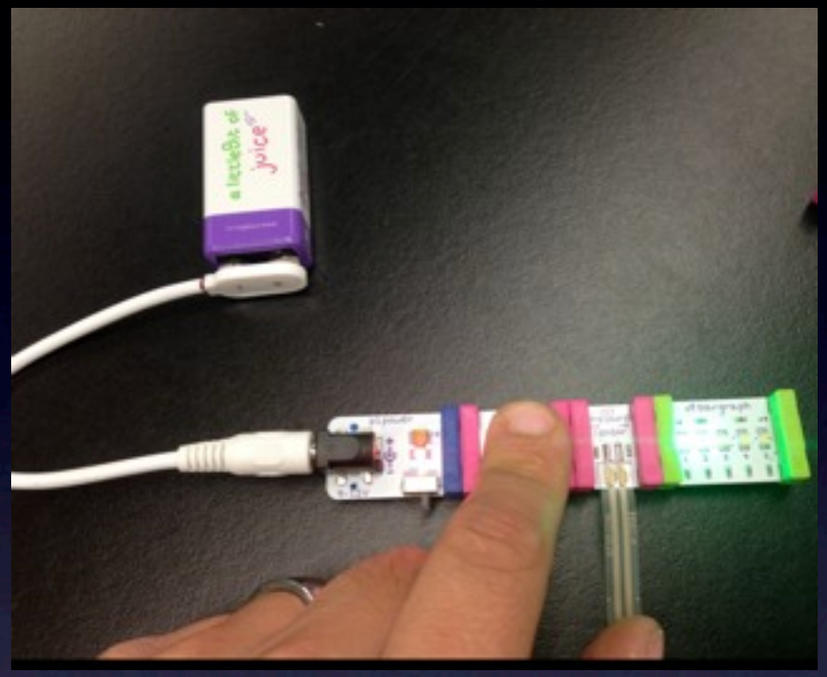

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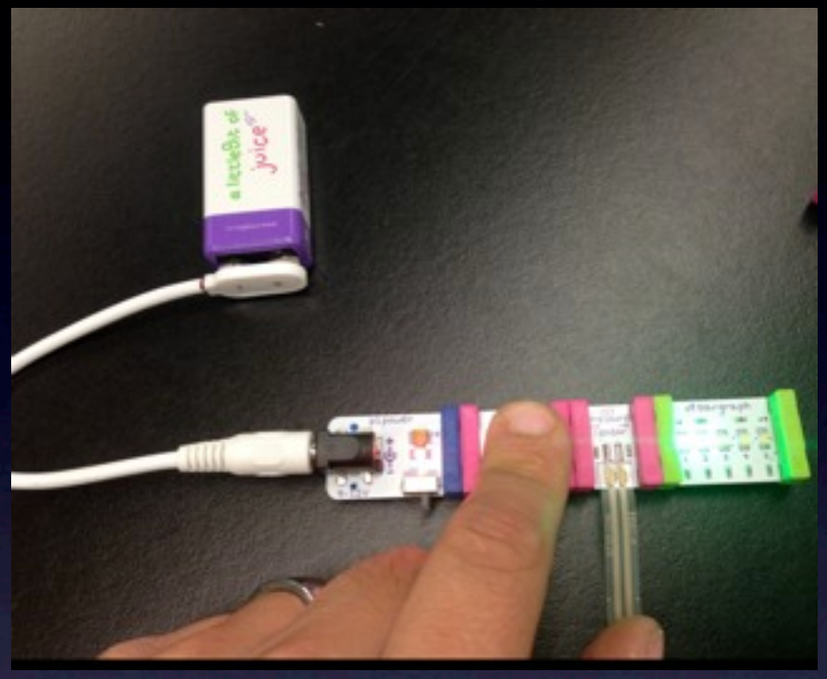

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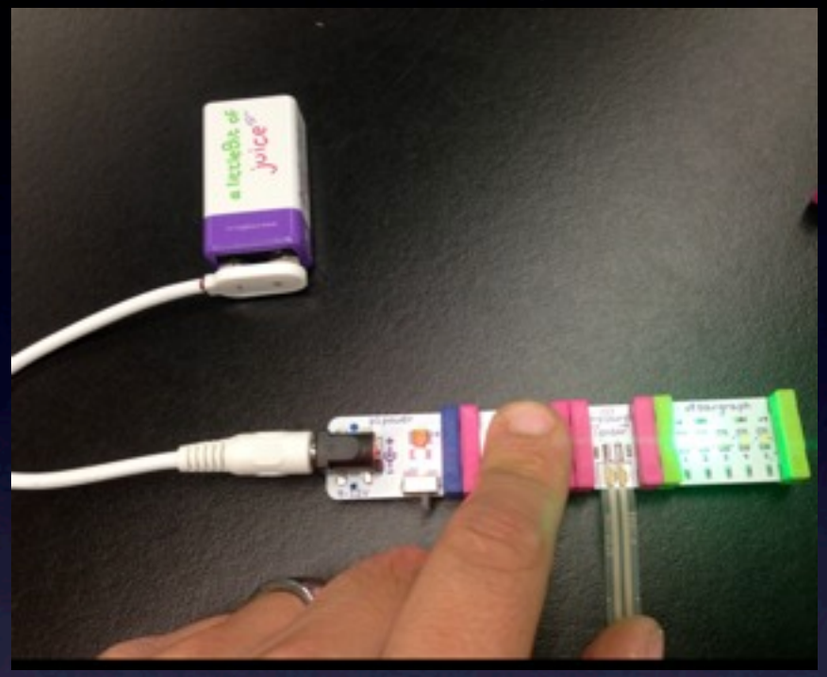

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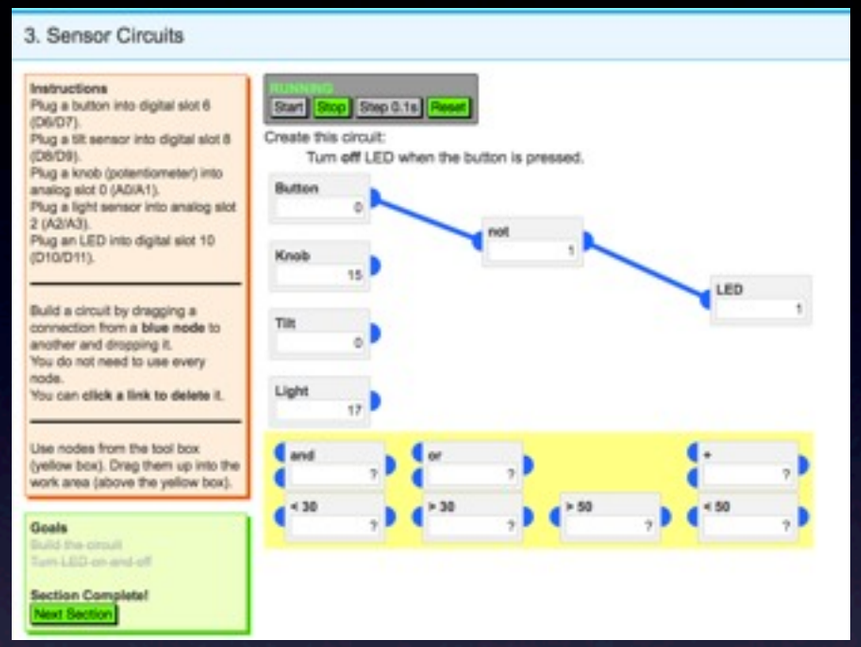

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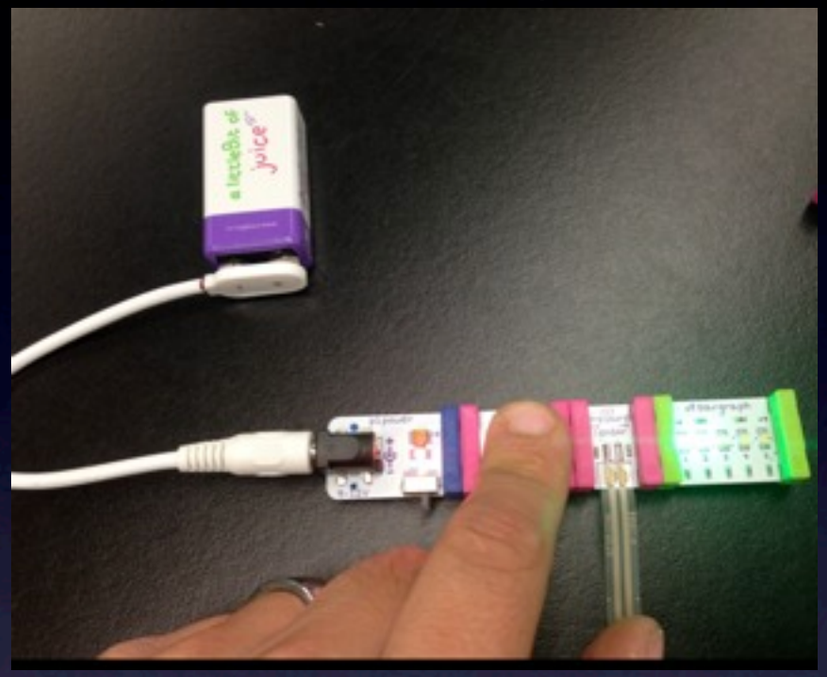

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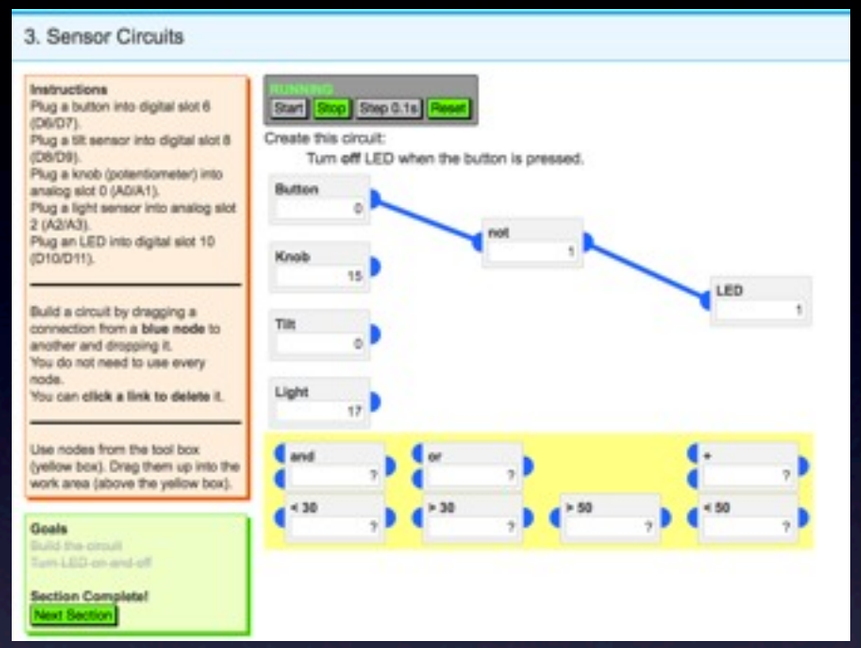

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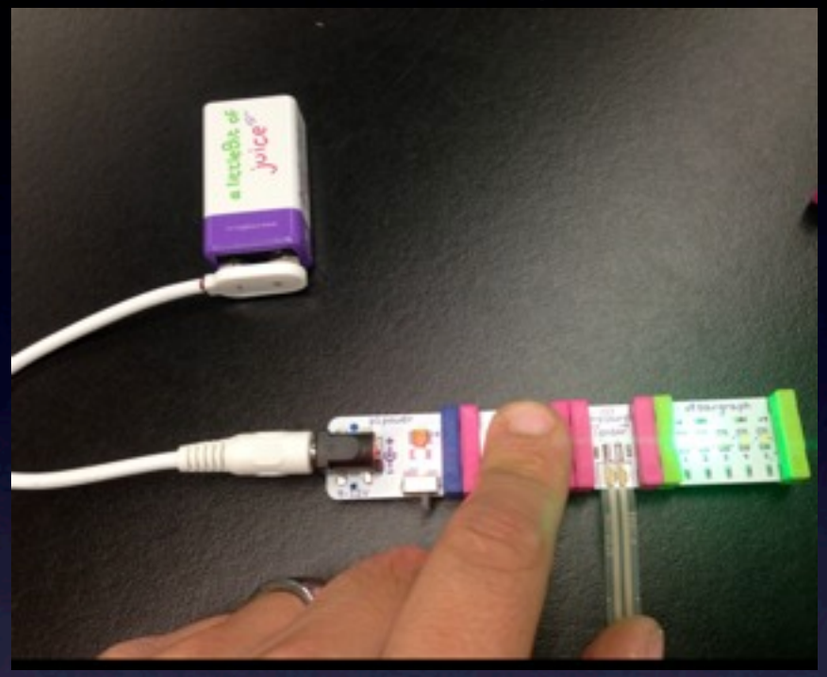

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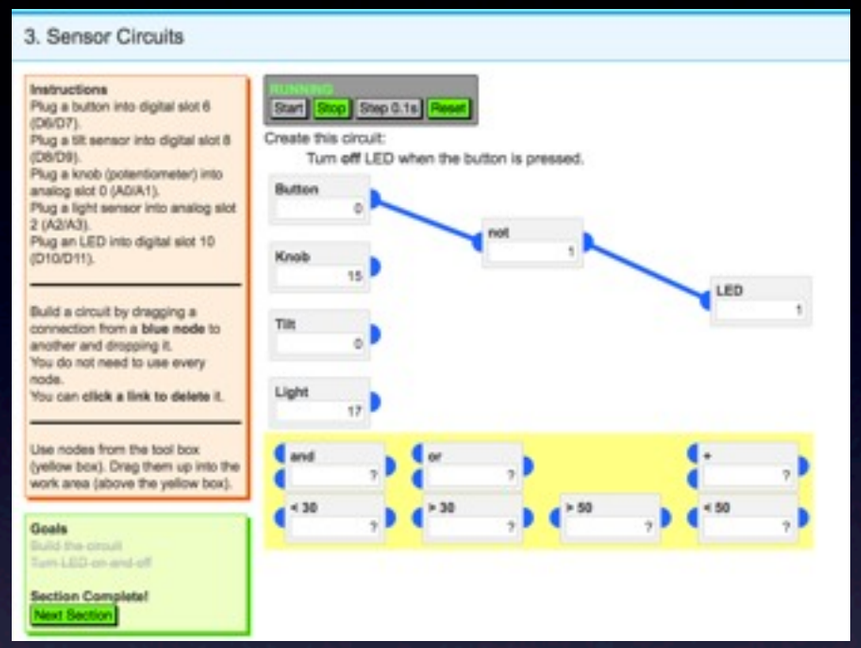

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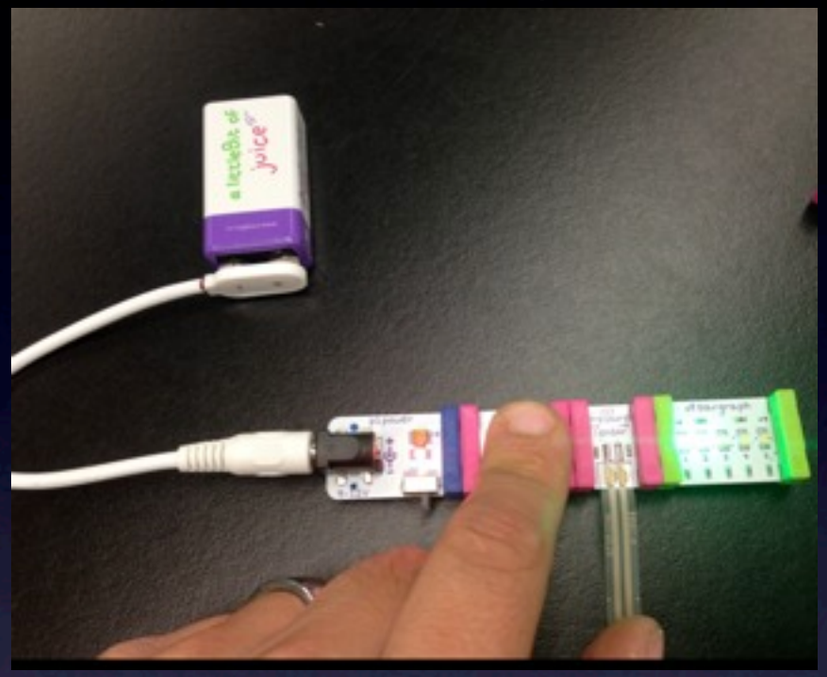

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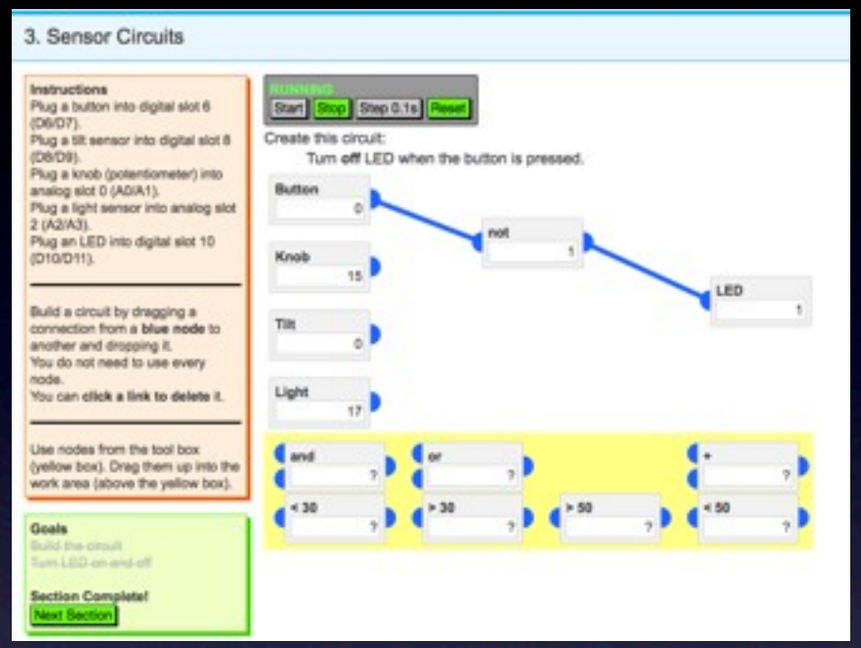

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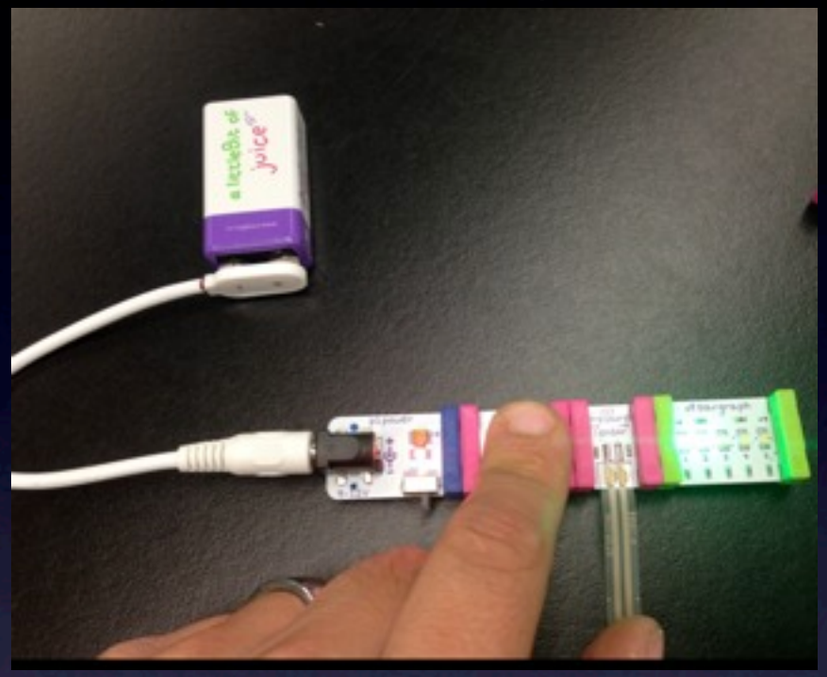

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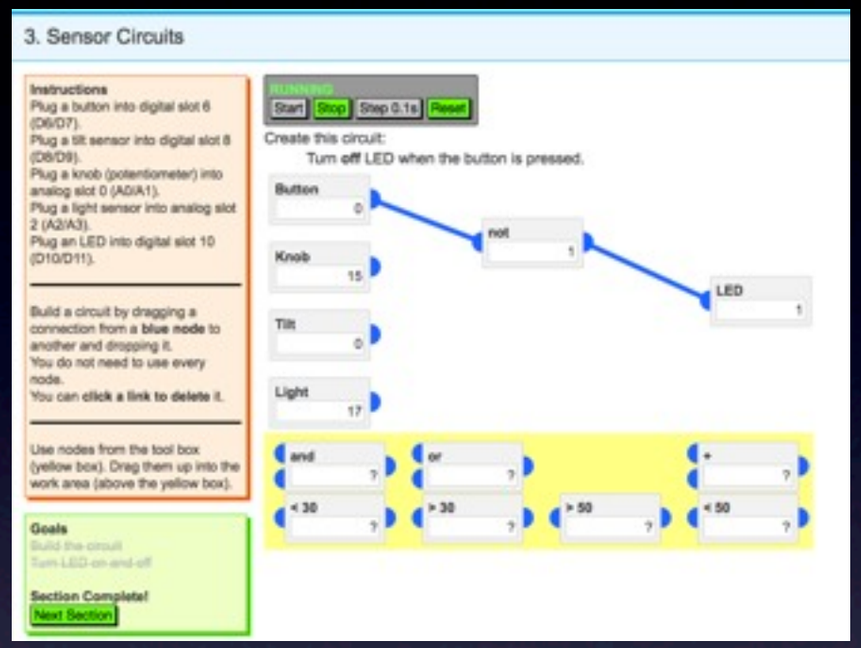

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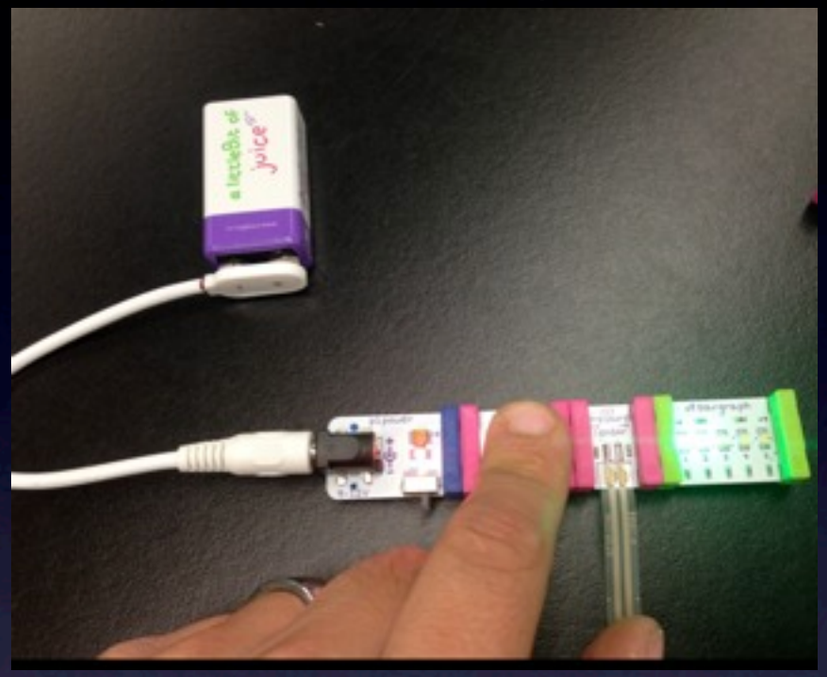

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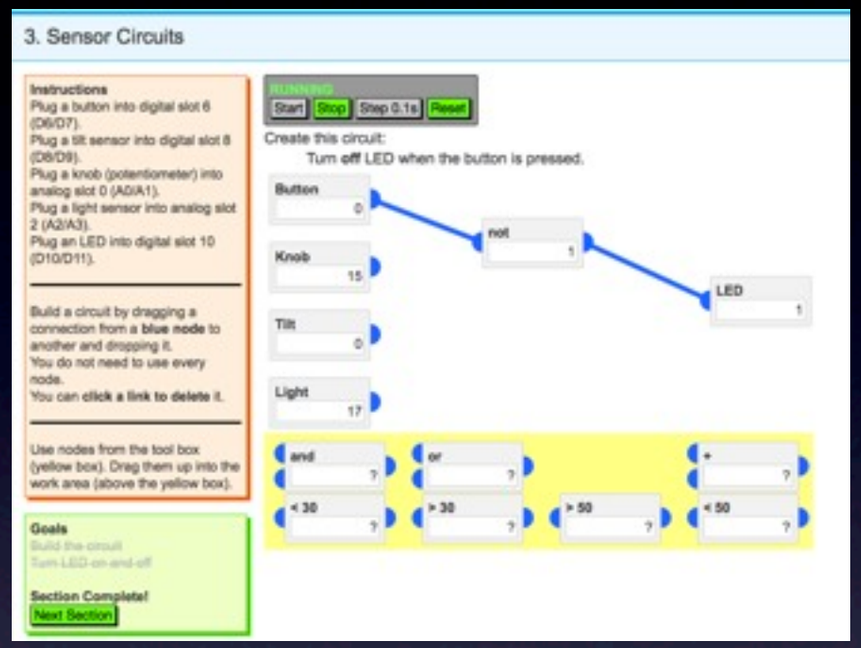

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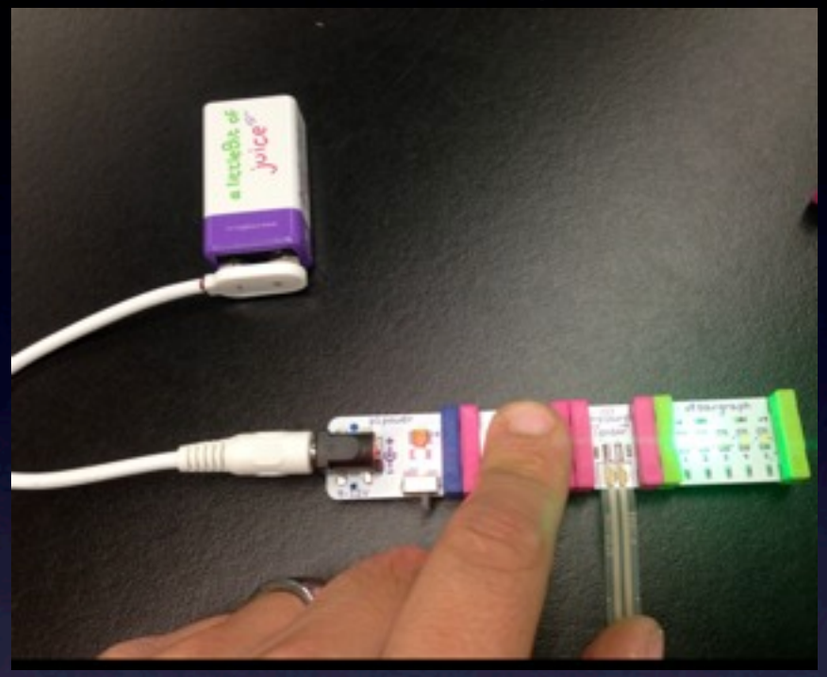

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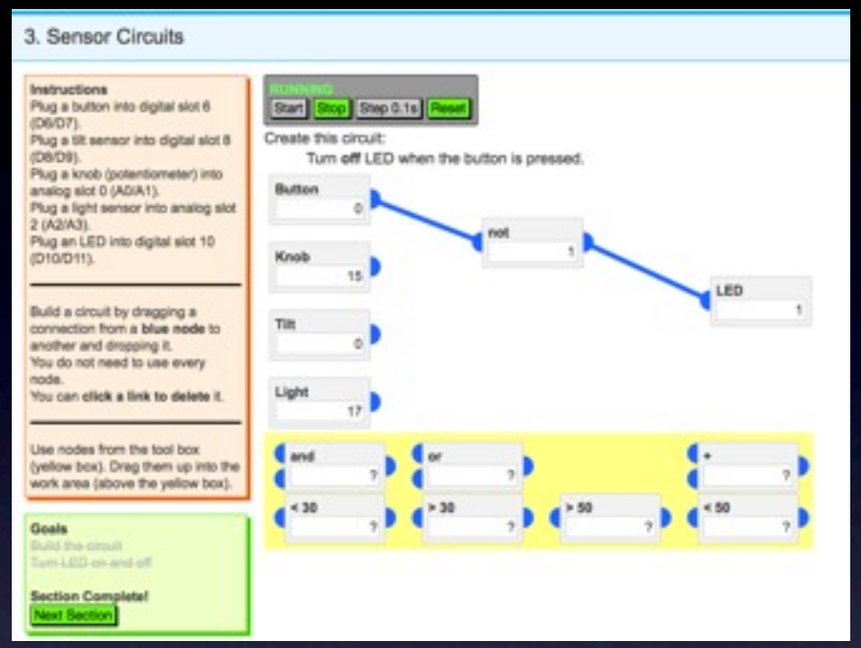

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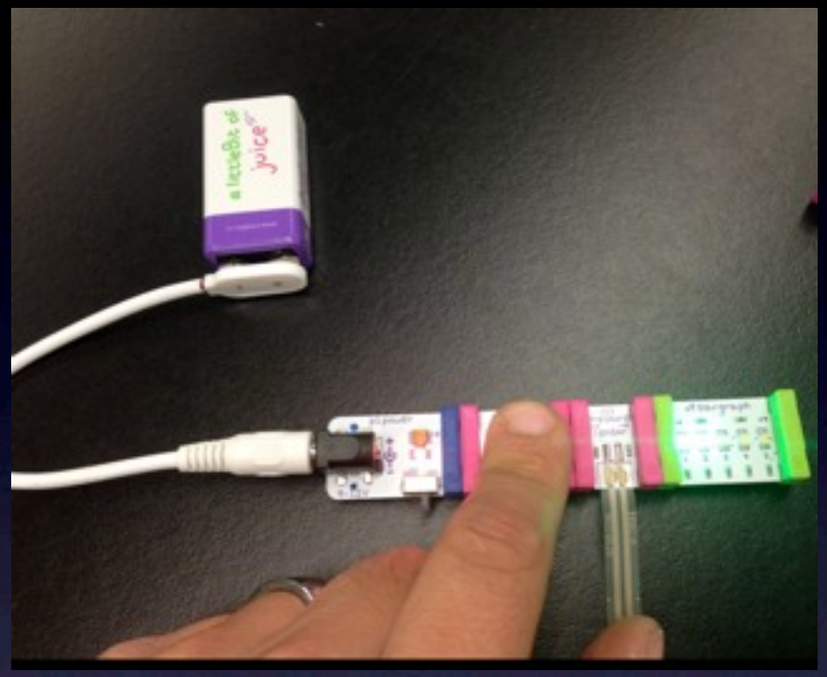

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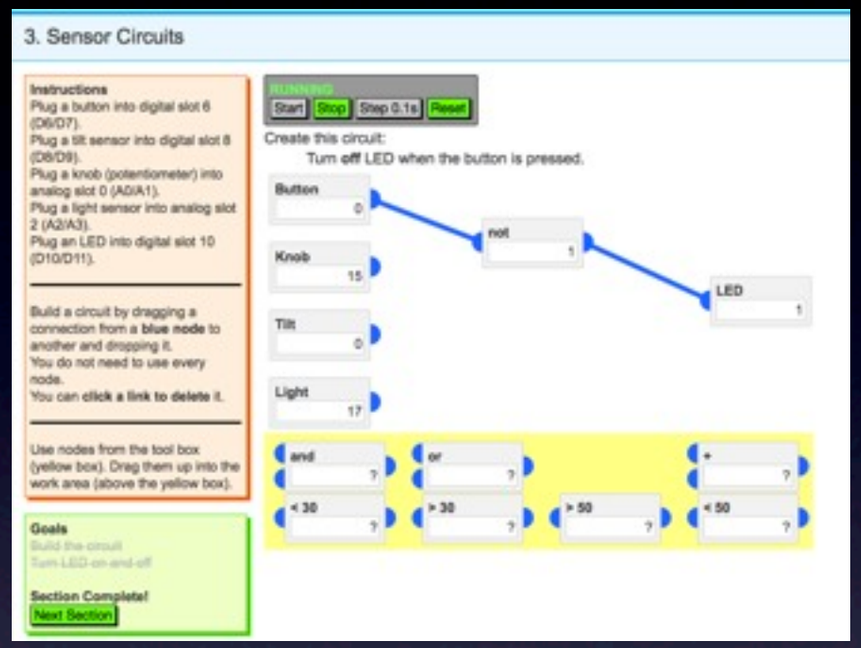

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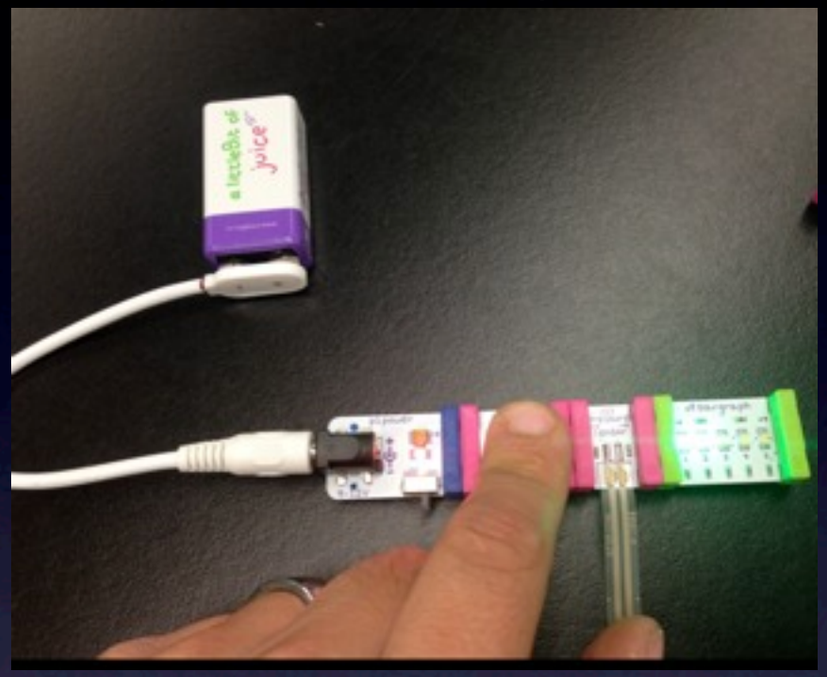

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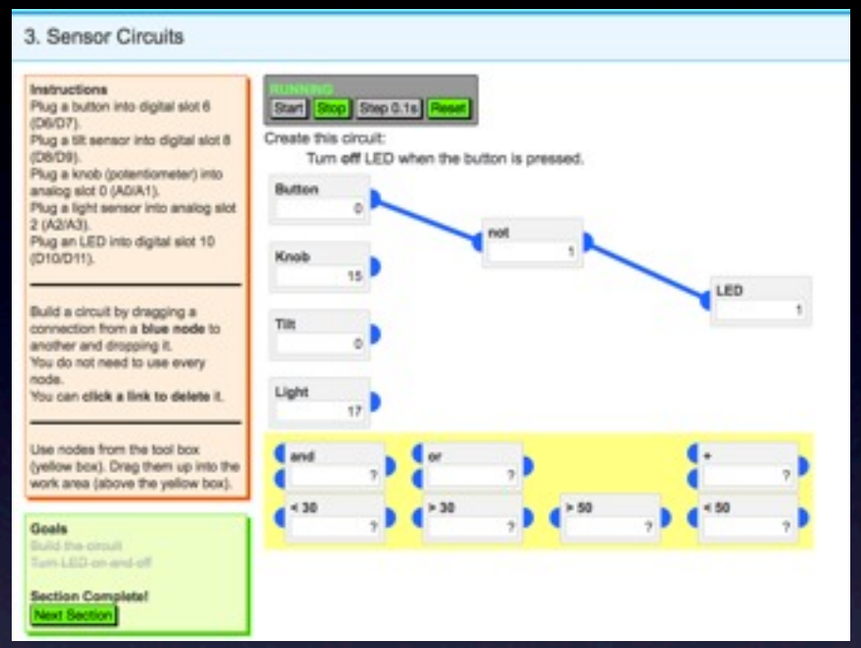

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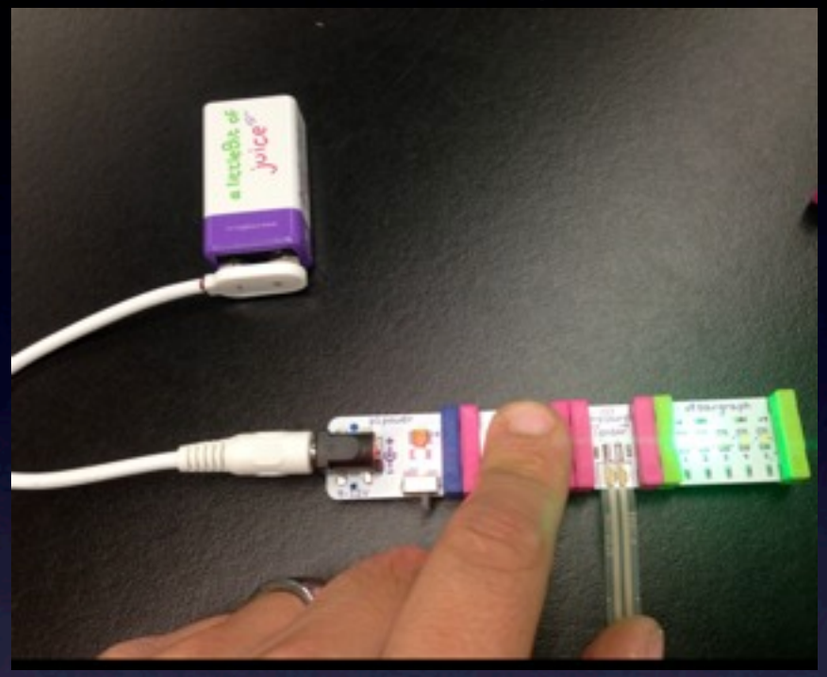

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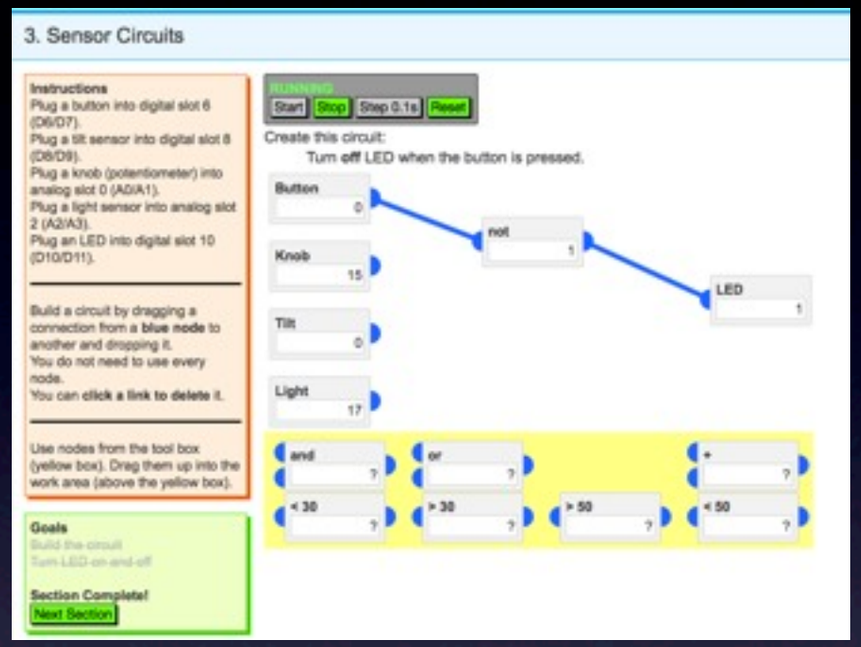

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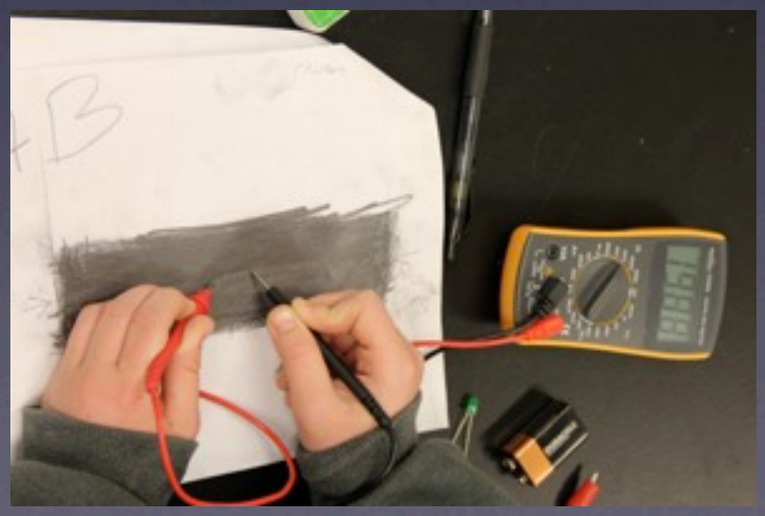
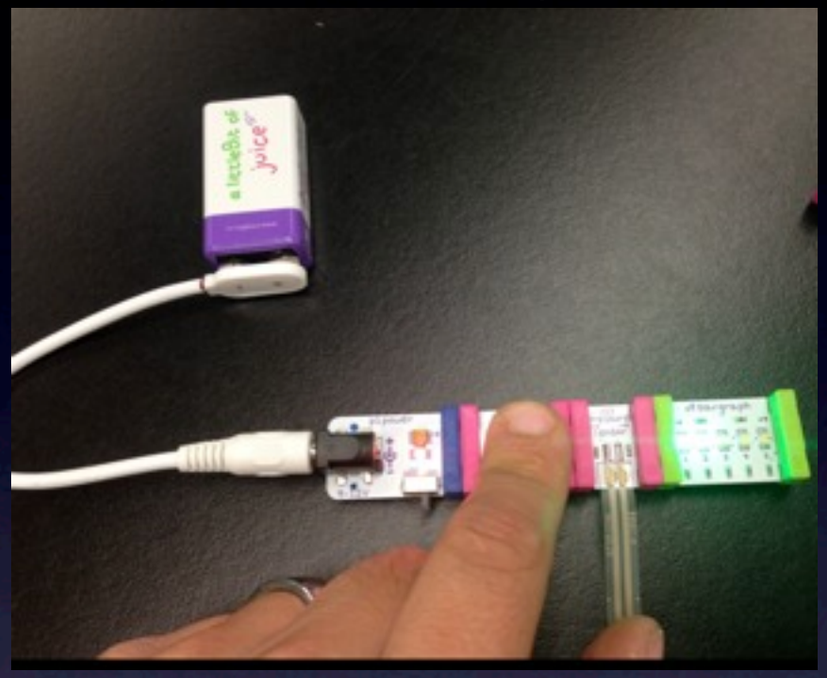
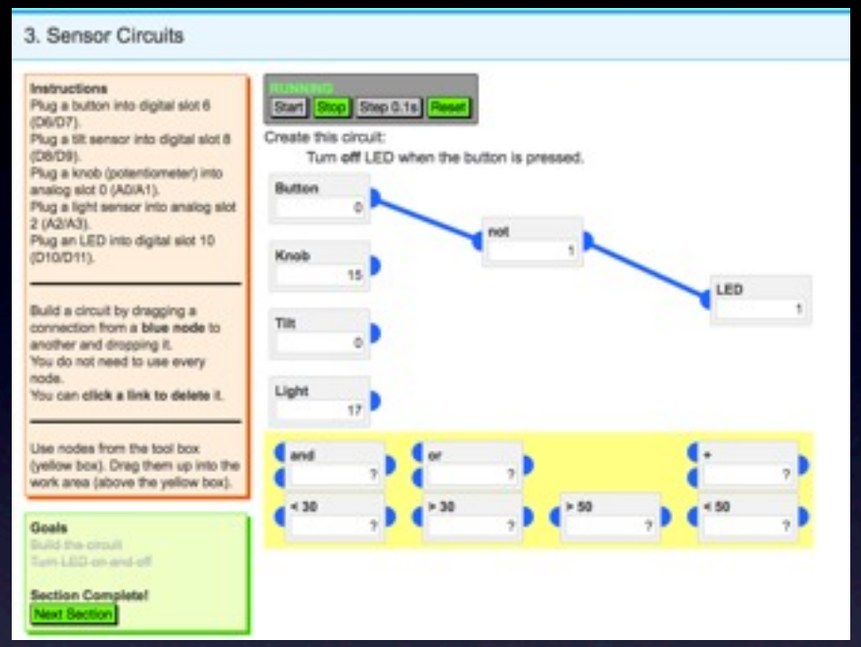


Lesson Plans

- Introduction to circuitry using a variety of sources (e.g. Little Bits and Manylabs software) to learn about them (Lessons #1).



Little Bits



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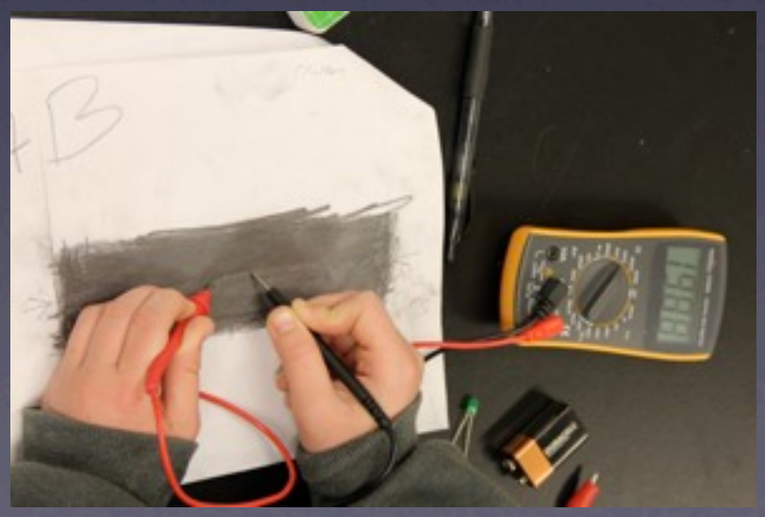

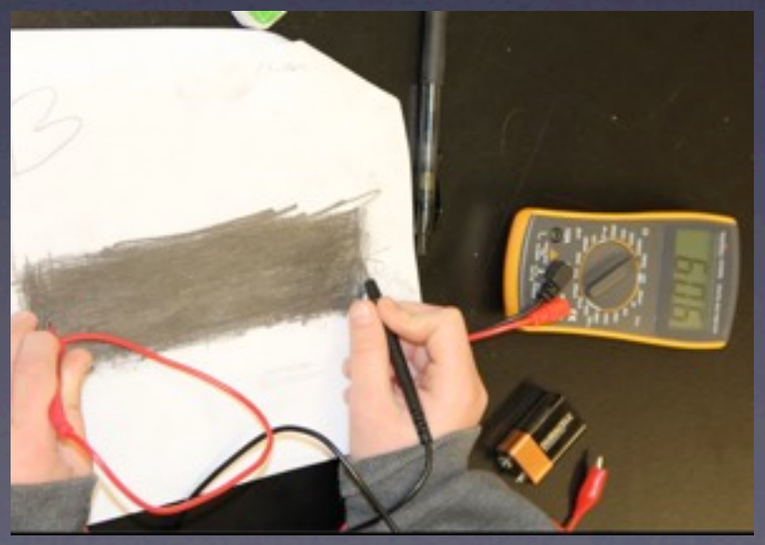

Lesson Plans (Cont'd)

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- Exploring Graphite Potentiometers (Lesson #3).

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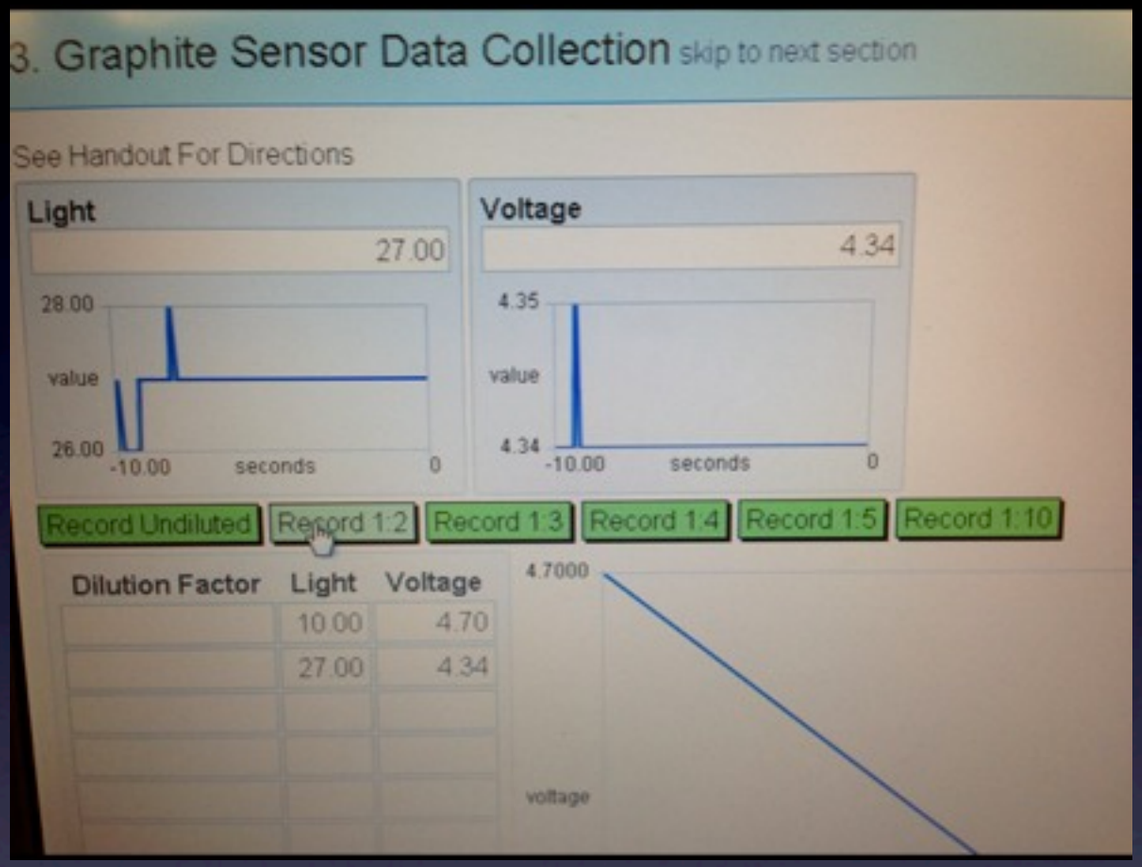

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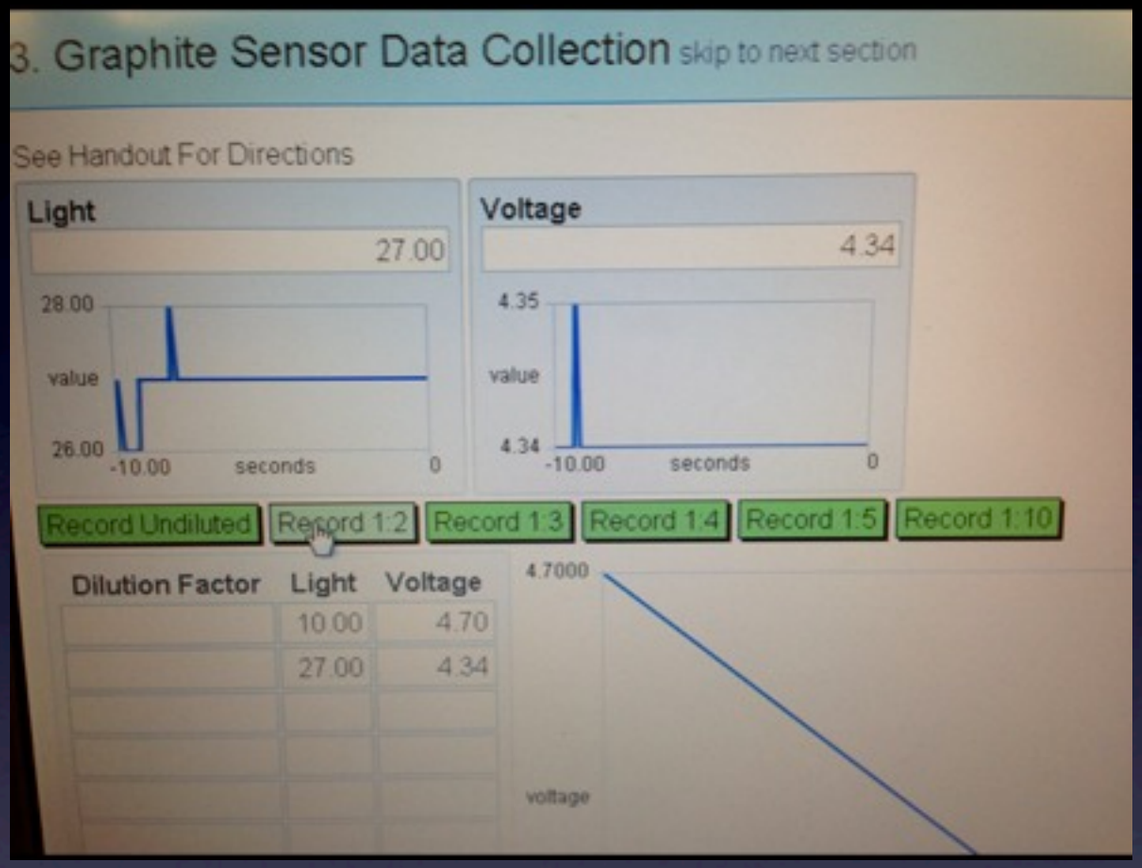

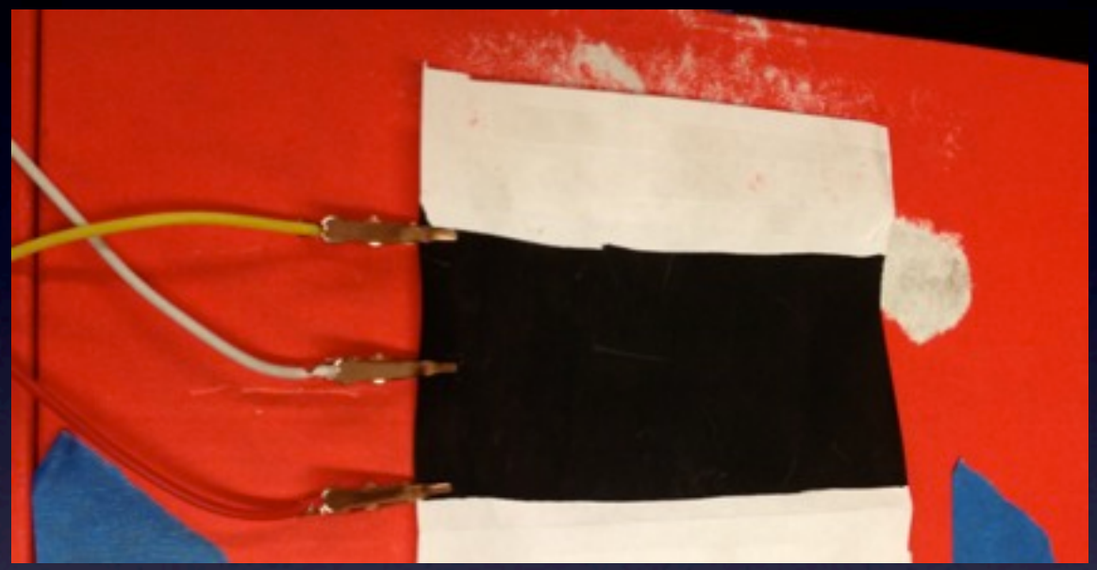

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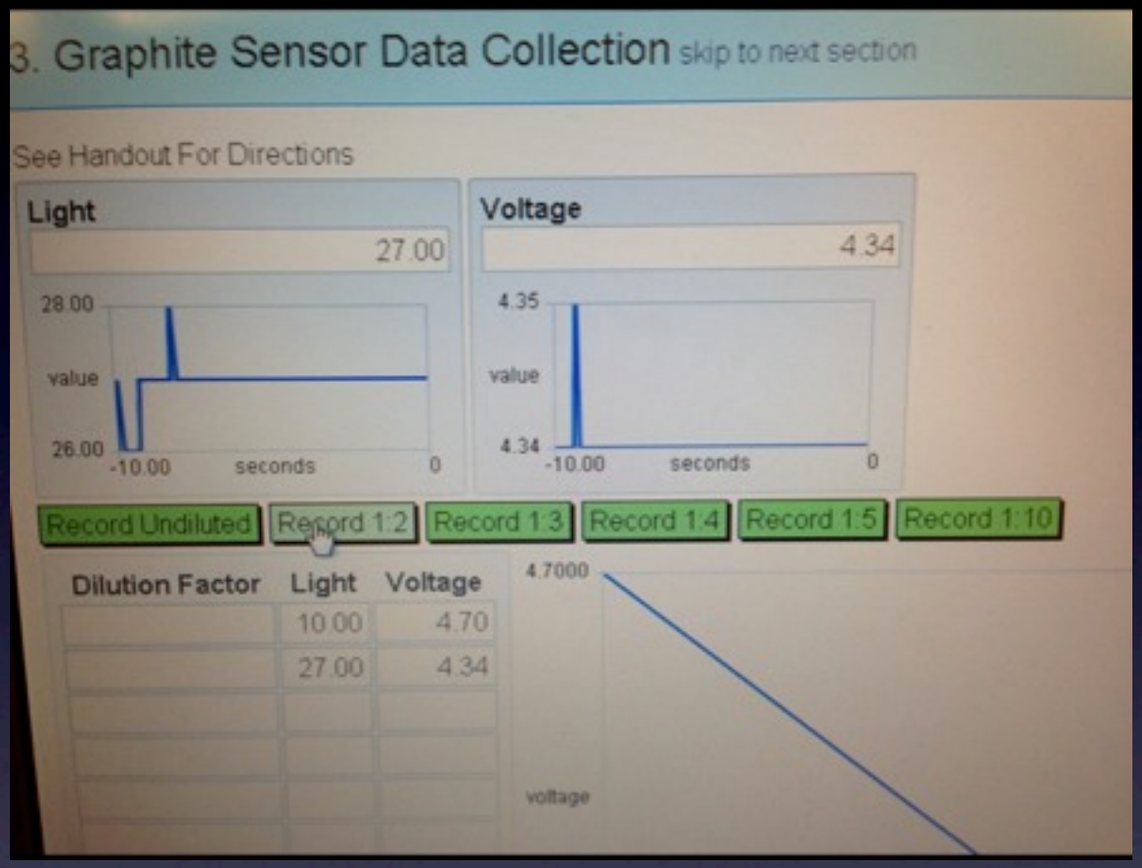

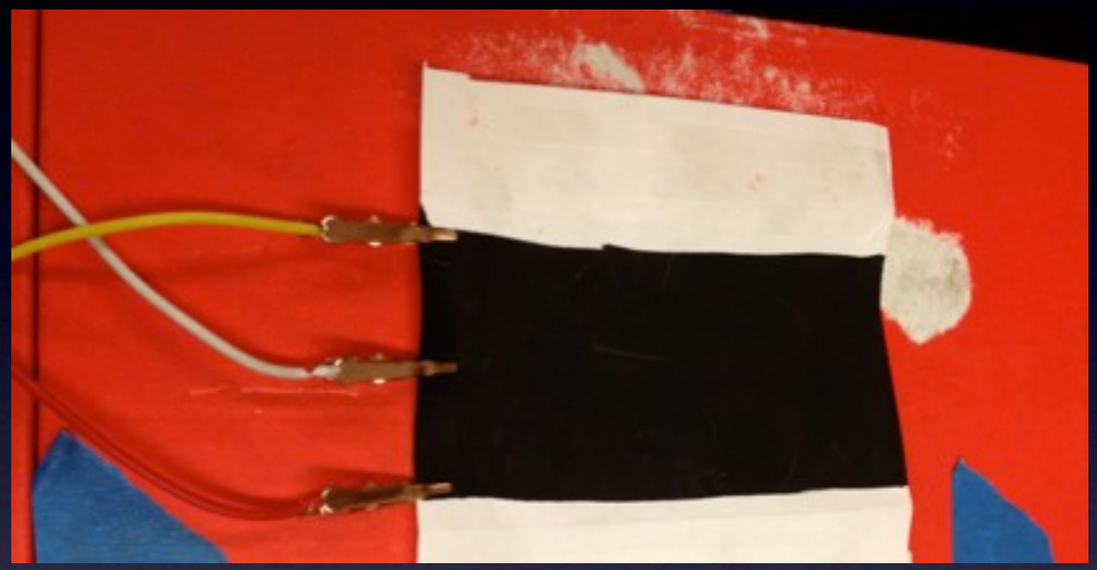

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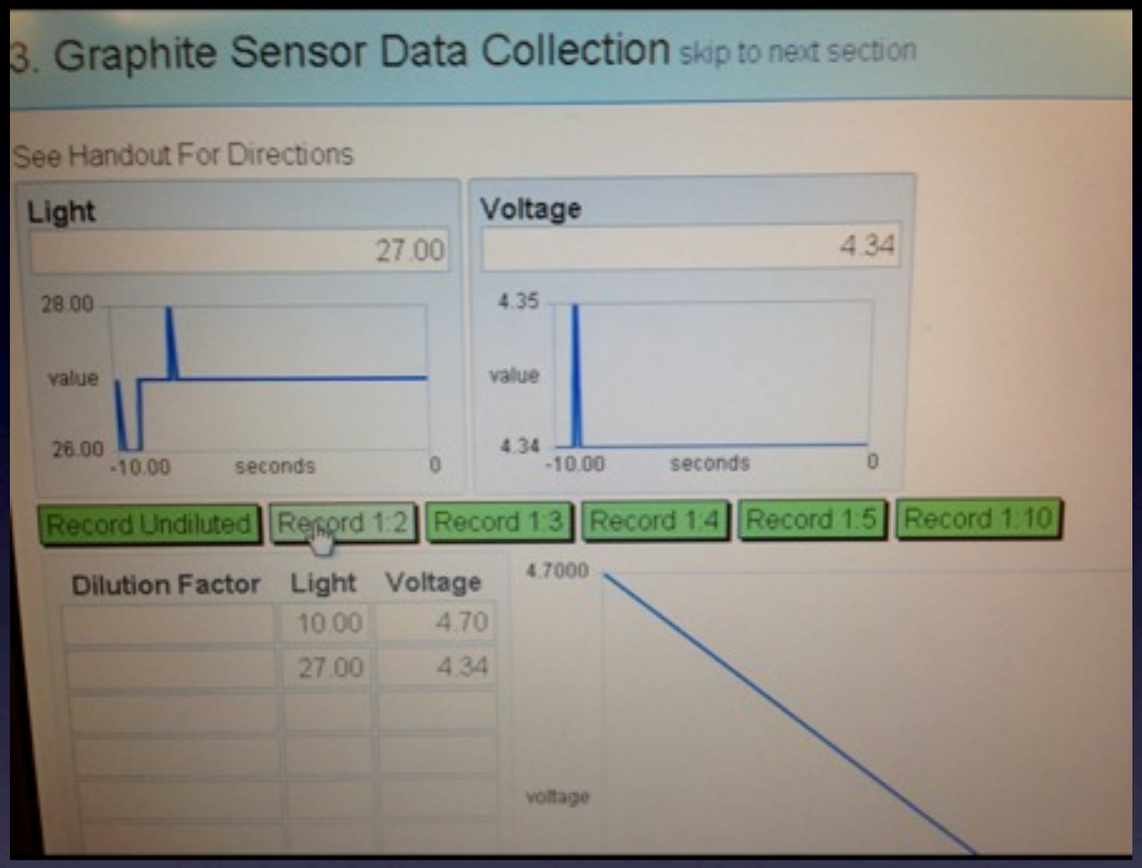

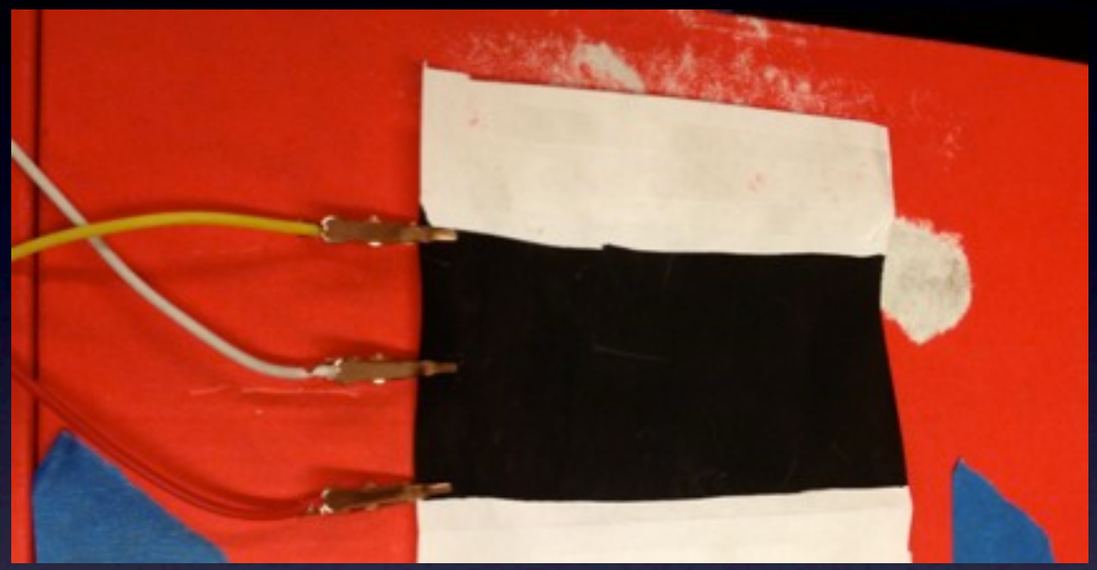

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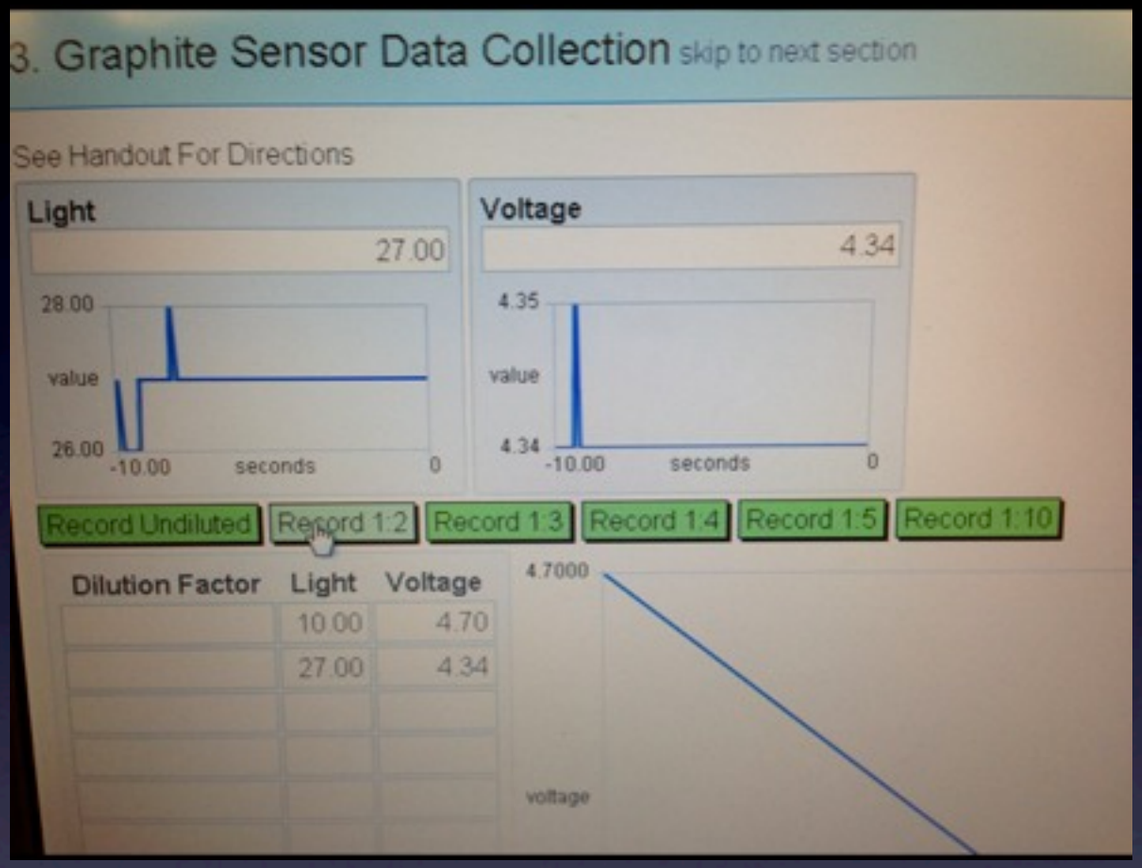

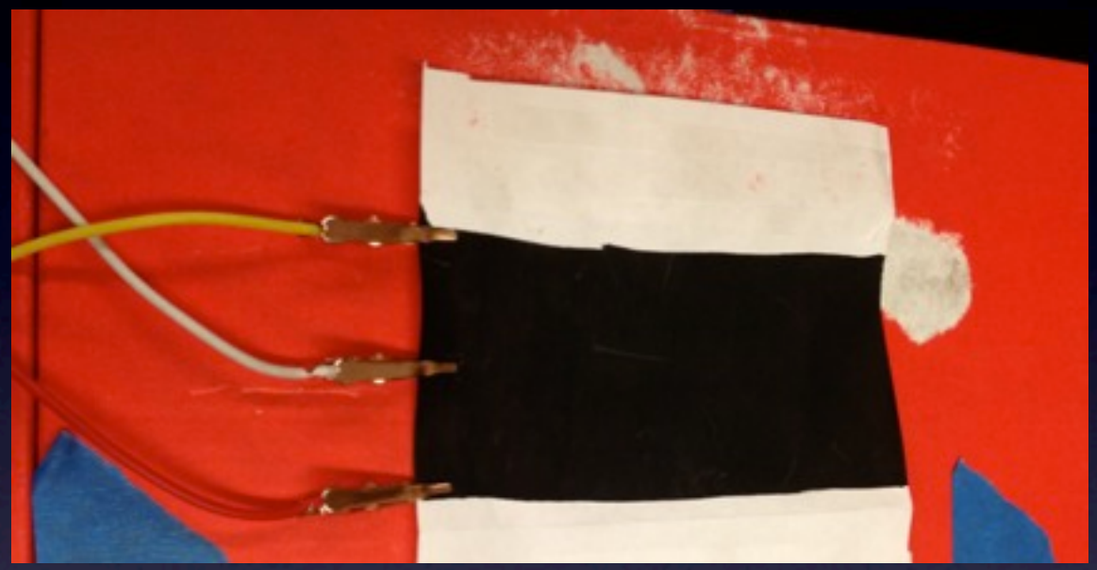

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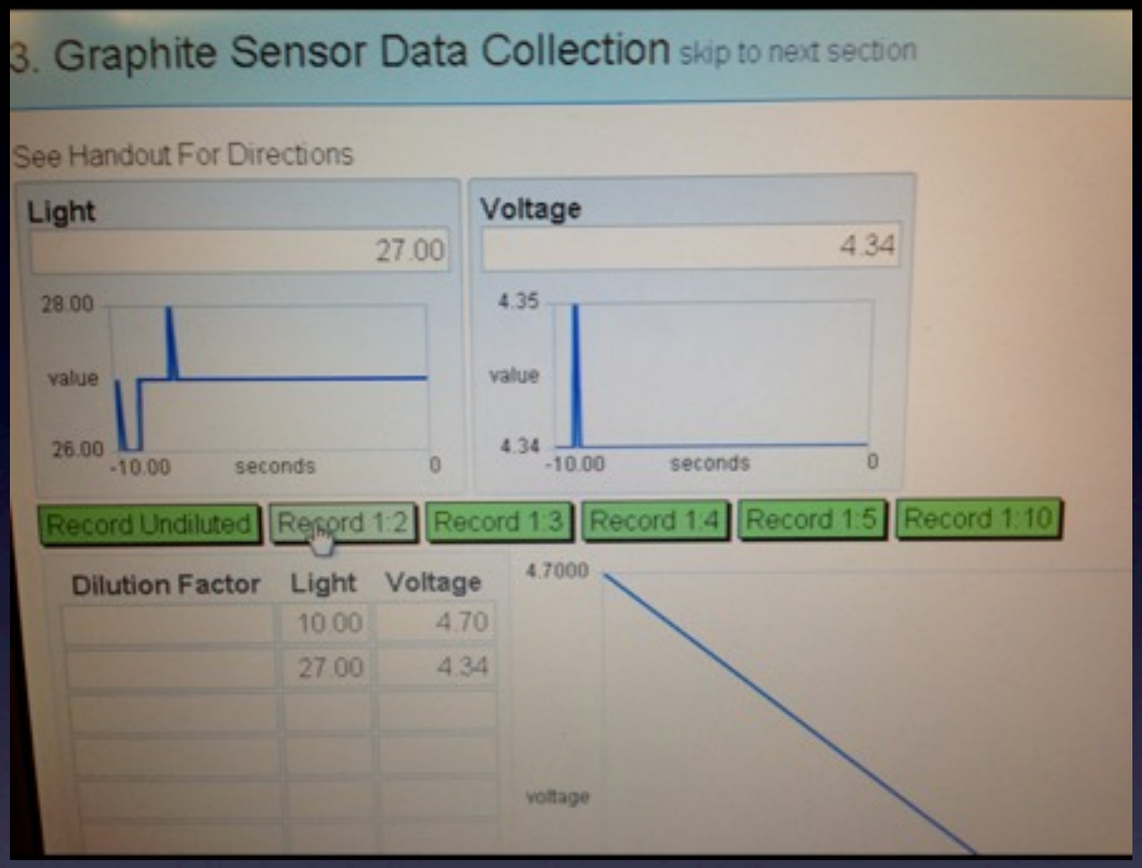

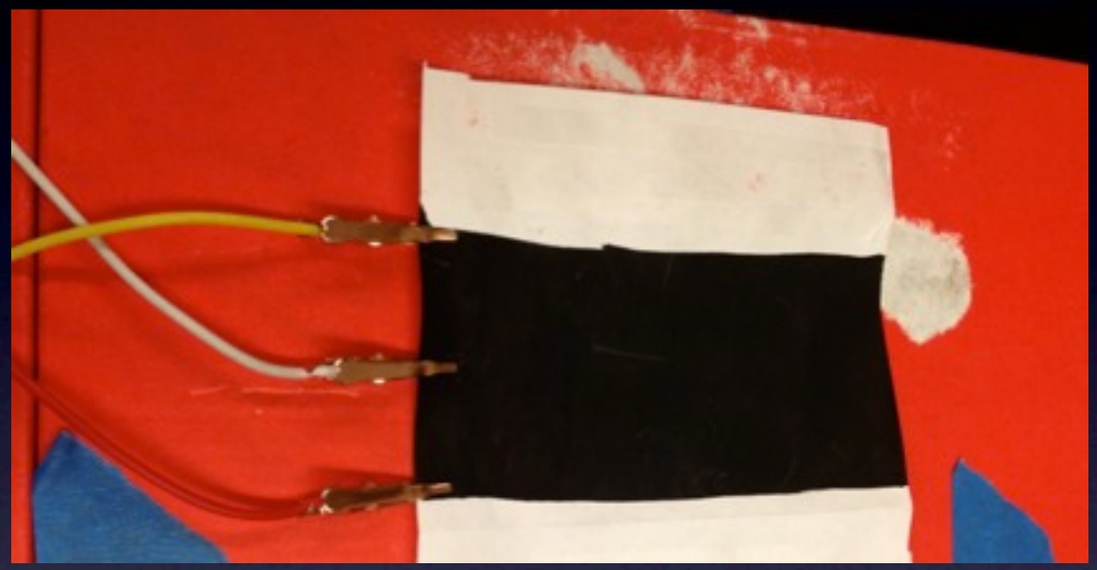

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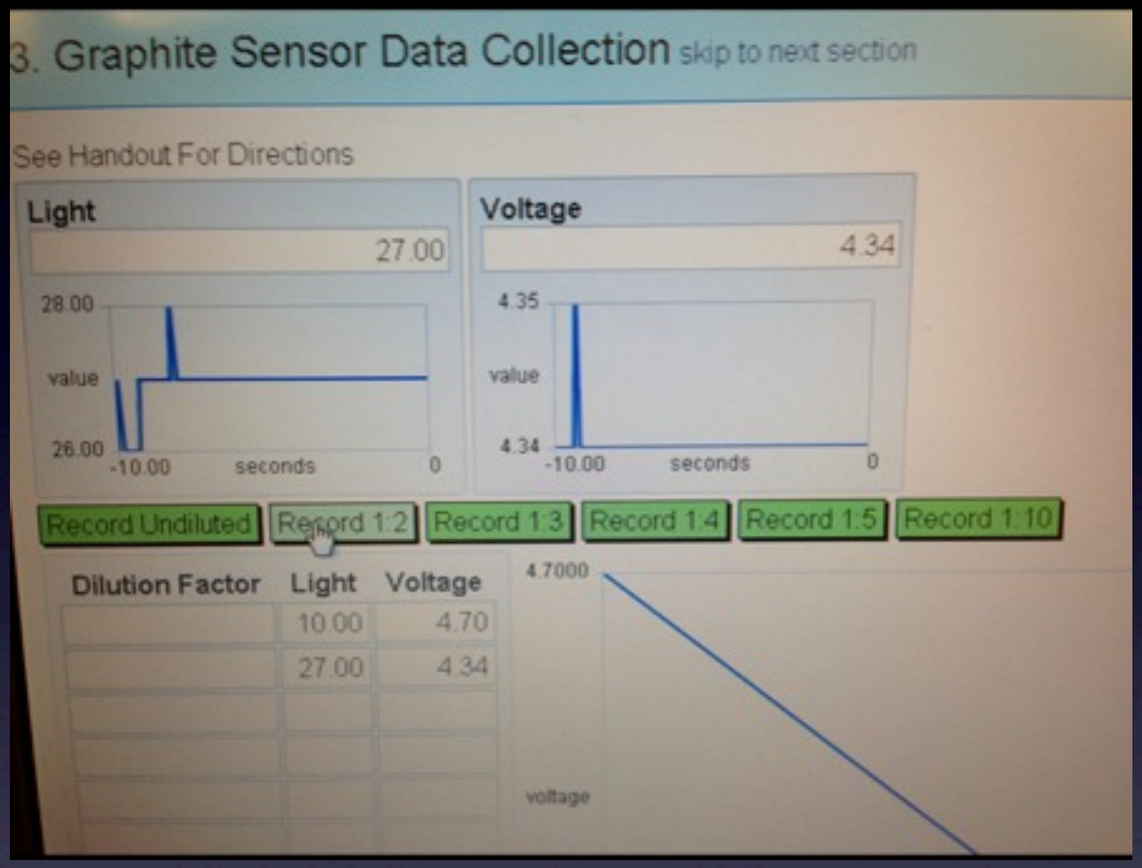

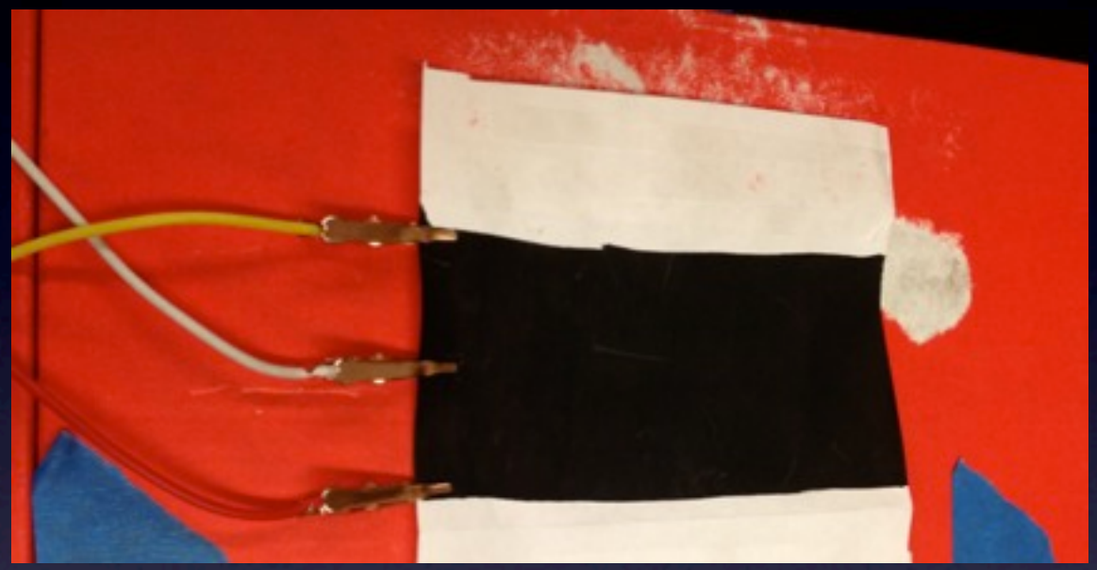

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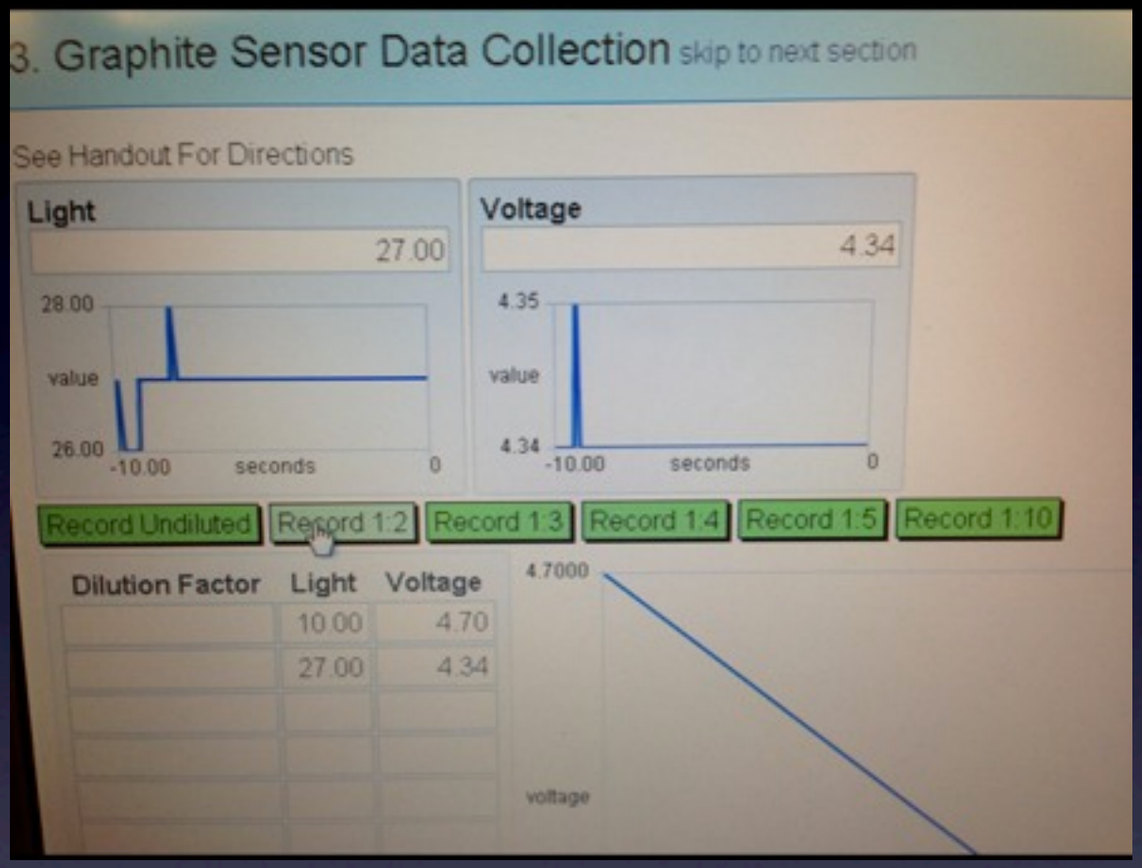
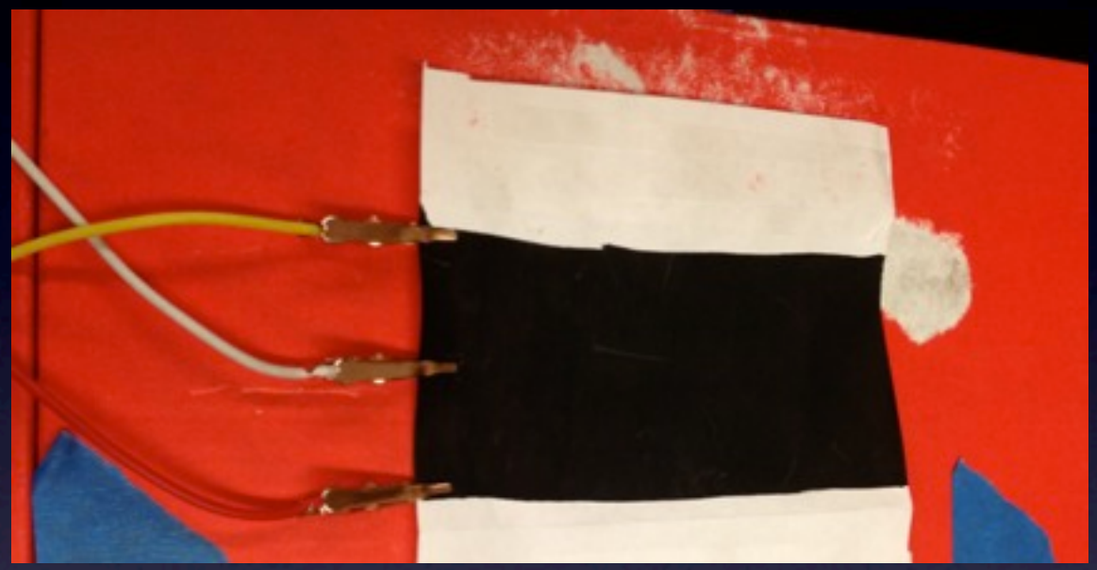
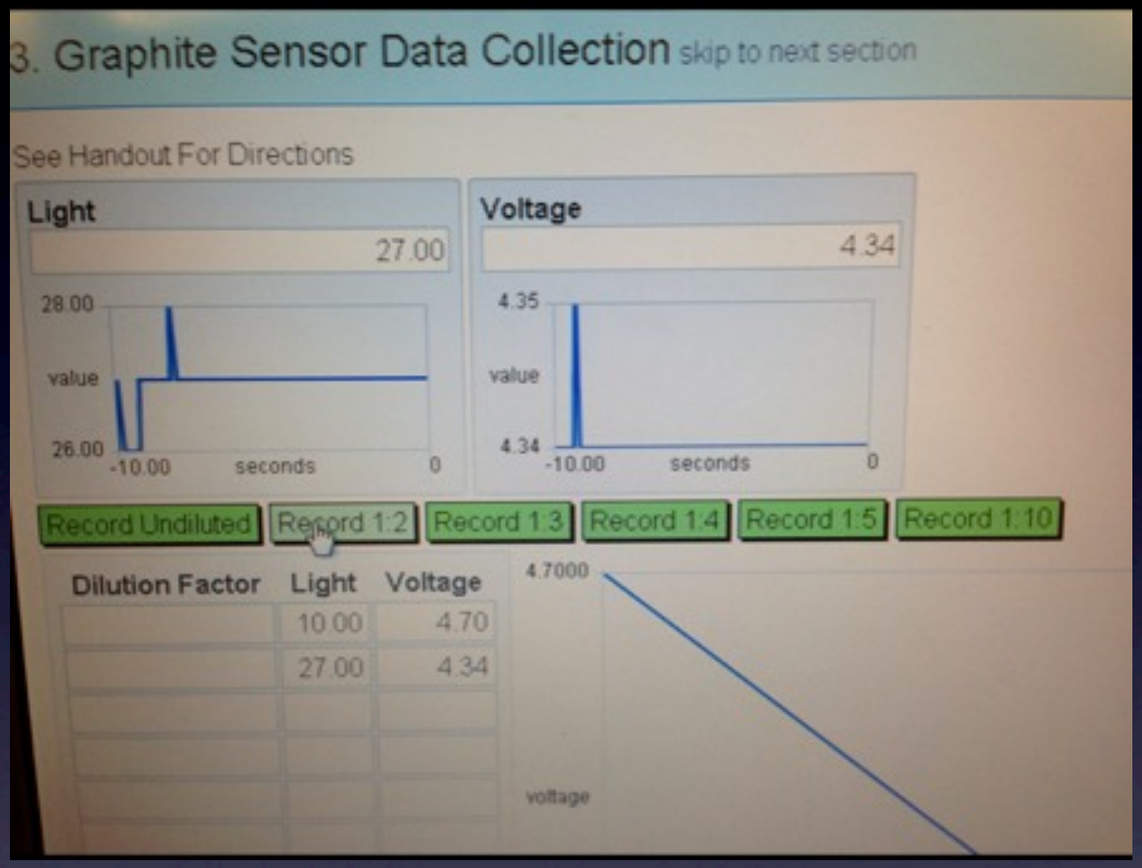


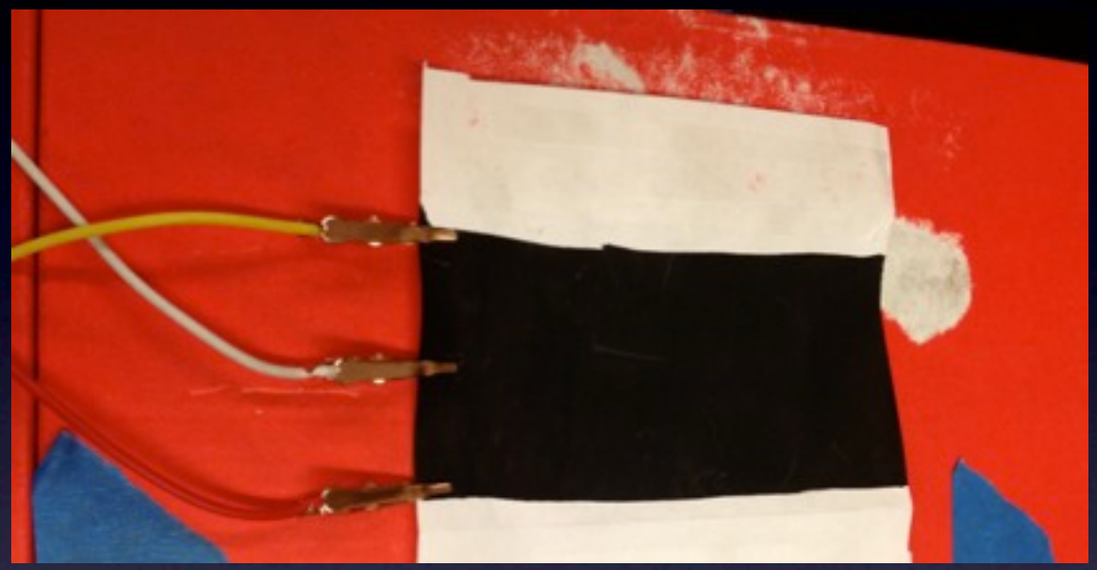


- Using a CNC machine as a platform for an autosampler (Lesson #4).

Lesson Plans (Cont'd)

- Exploring Graphite Potentiometers (Lesson #3).





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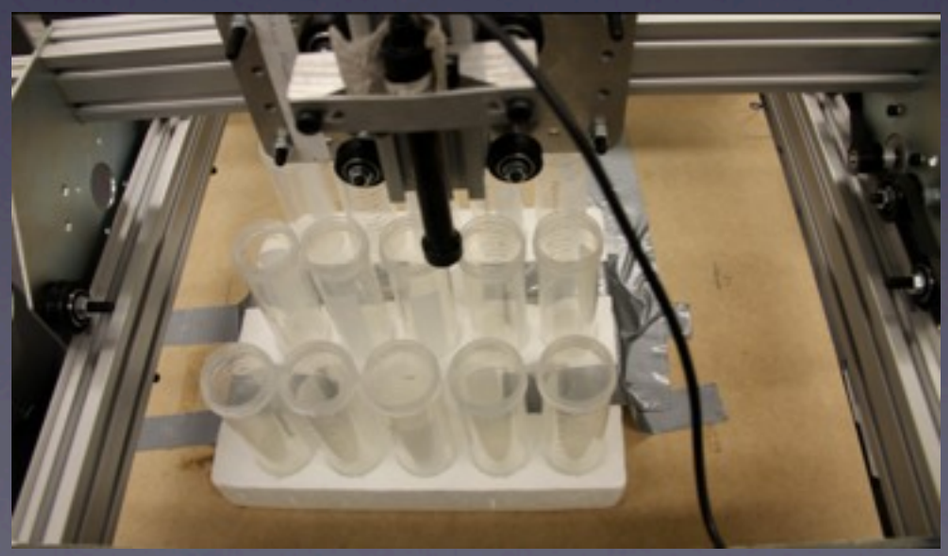


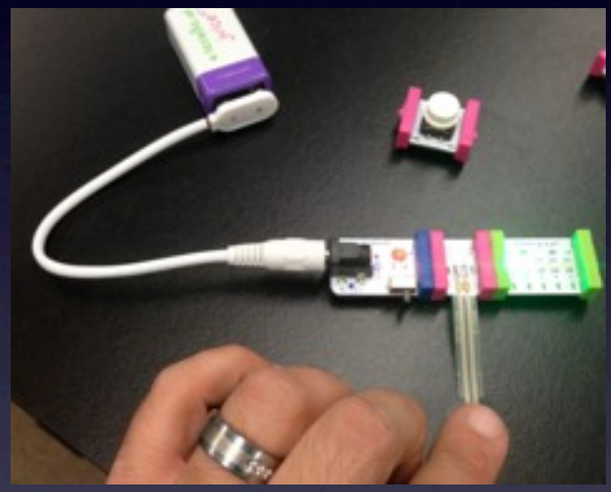
Lesson #1: Basic Circuitry

Overview:

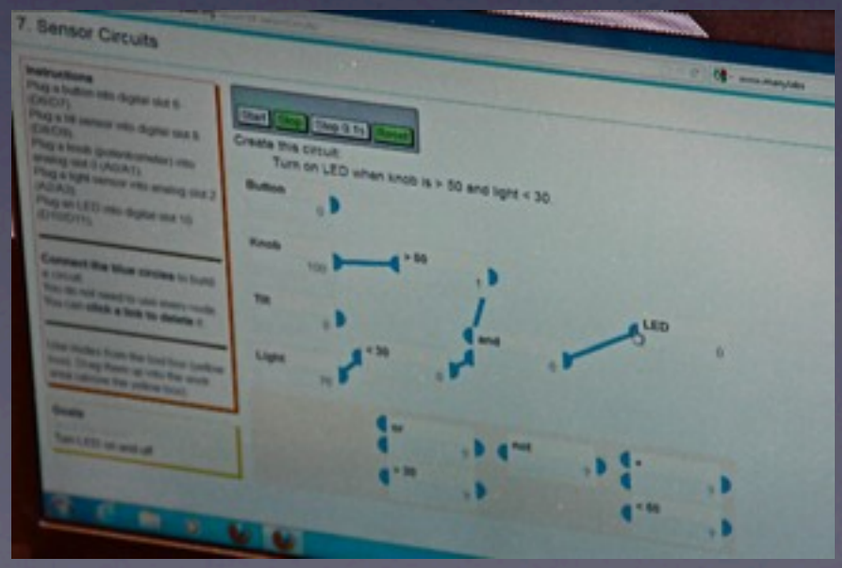
To understand how various input/output modes can affect an outcome in a circuit by:

Using Little Bits parts to investigate circuits and develop input/ output statements

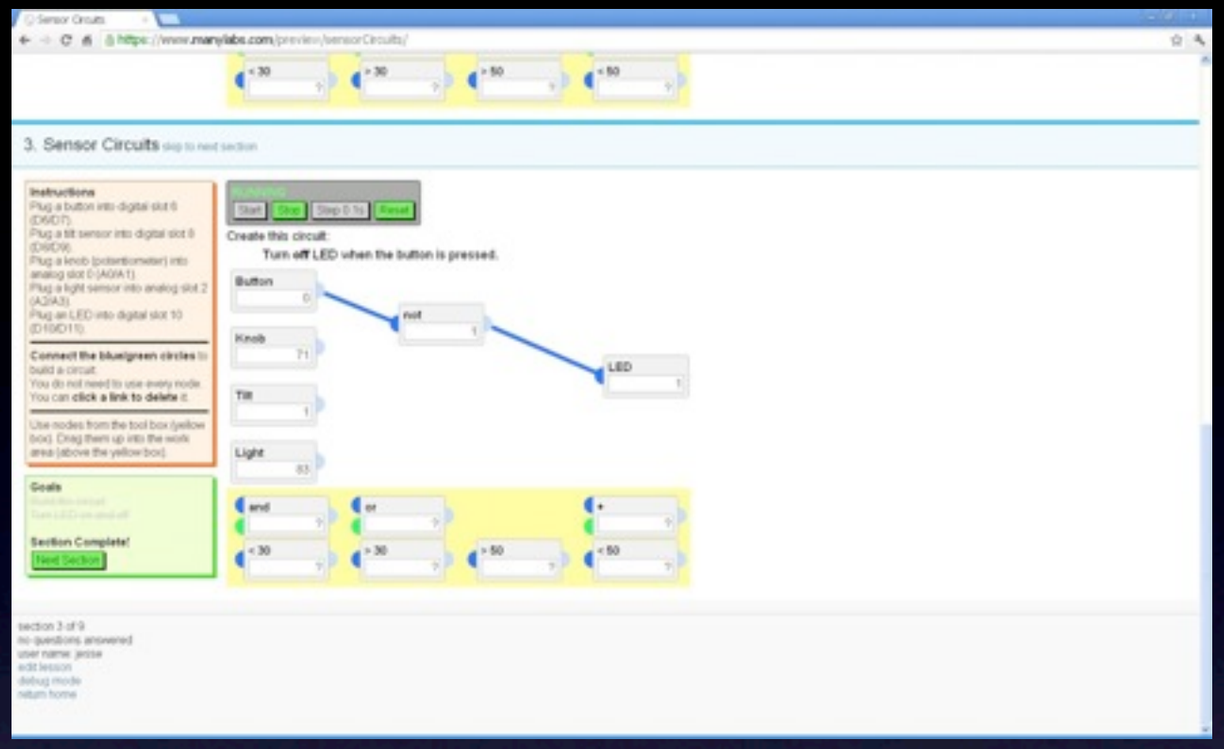
Manipulatives are good for Kinesthetic Learners (Middle School)



Logic statements are good for forming complex circuits in codes and programming (High School)



ManyLabs Activities



Another Example of ManyLabs Software...

And....

A tabulation step

Circuit #	Button	Knob	Light	Tilt	And	Or	Not	+	<30	>30	<50	>50
1												
2	y						y					
3												
4												
5												
6												
7												

Place a "Y" for each part "used" to complete the circuit in the table below after completing the task on the computer for each exercise:

After tabulation, you can create coding sentence structure for programming languages.

If you know: Button= a switch; then “Copy & Paste Code”
http://www.arduino.cc/en/Tutorial/Switch

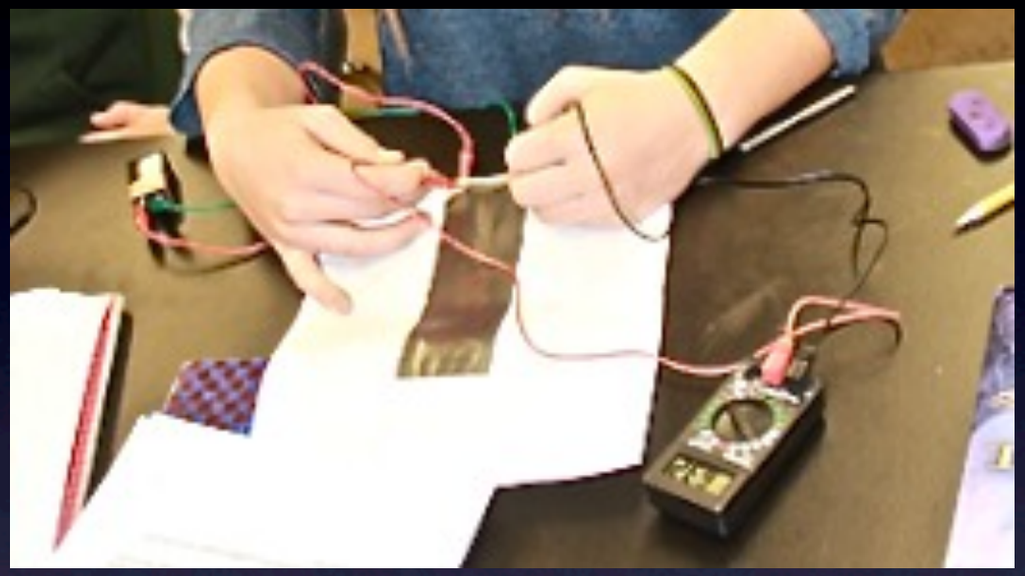
```
 *
 * Each time the input pin goes from LOW to HIGH (e.g. because of a push-button
 * press), the output pin is toggled from LOW to HIGH or HIGH to LOW.  There's
 * a minimum delay between toggles to debounce the circuit (i.e. to ignore
 * noise).
 *
 * David A. Mellis
 * 21 November 2006
 */

int inPin = 2;         // the number of the input pin
int outPin = 13;       // the number of the output pin

int state = HIGH;      // the current state of the output pin
int reading;           // the current reading from the input pin
int previous = LOW;    // the previous reading from the input pin

// the follow variables are long's because the time, measured in miliseconds,
// will quickly become a bigger number than can be stored in an int.
long time = 0;         // the last time the output pin was toggled
long debounce = 200;   // the debounce time, increase if the output flickers
```

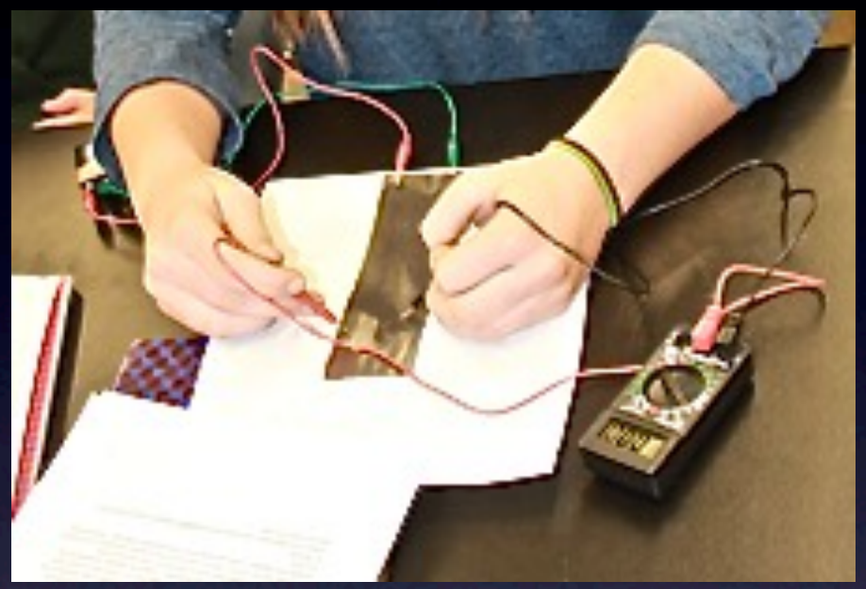
```
void setup()
{
  pinMode(inPin, INPUT);
  pinMode(outPin, OUTPUT);
}

void loop()
{
  reading = digitalRead(inPin);

  // if the input just went from LOW and HIGH and we've waited long enough
  // to ignore any noise on the circuit, toggle the output pin and remember
  // the time
  if (reading == HIGH && previous == LOW && millis() - time > debounce) {
    if (state == HIGH)
      state = LOW;
    else
      state = HIGH;

    time = millis();
  }

  digitalWrite(outPin, state);

  previous = reading;
}
```

Lesson #2: Graphite Potentiometers

Goal: To understand what a potentiometer is and what it does

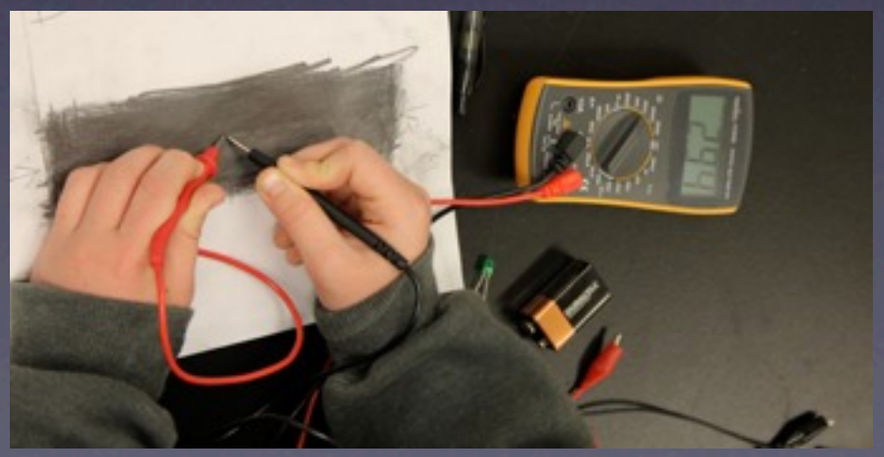
Measure Variable Voltage

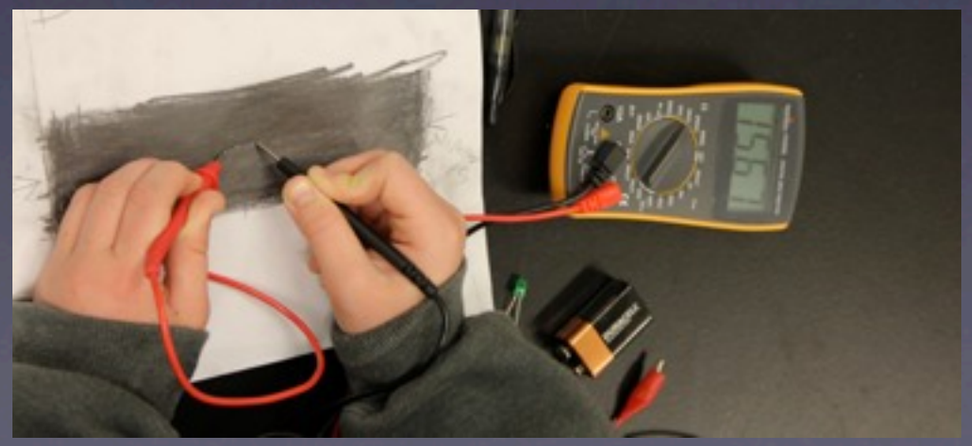




Or...

Measure Variable Resistance





Lesson #2

Building A Graphite Circuit

Students get to create a circuit with graphite and then test its voltage or resistance using a voltmeter or LED.

Leads of Voltmeter are closest to source:
Reading=6.15V from a 9V battery.

Leads of Voltmeter are farthest from source:
Reading - 167.9mV from a 9V battery.

Hook an LED to resistive layer (graphite) and see what happens...

Lesson #3: Exploring Graphite Potentiometers using ManyLabs Software

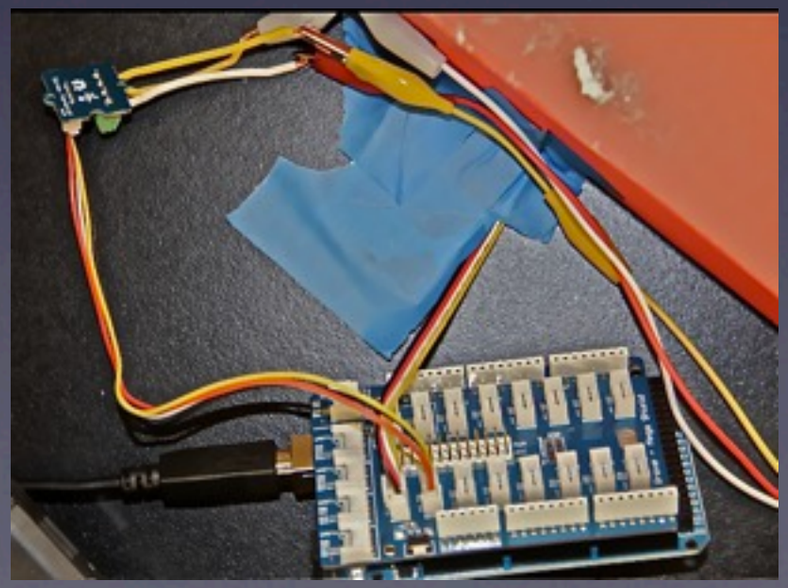
Goal: To learn how to interpret data and determine a relationship between two variables (i.e., light and voltage)

Set Up:

Dilution

Bare Conductive Paint

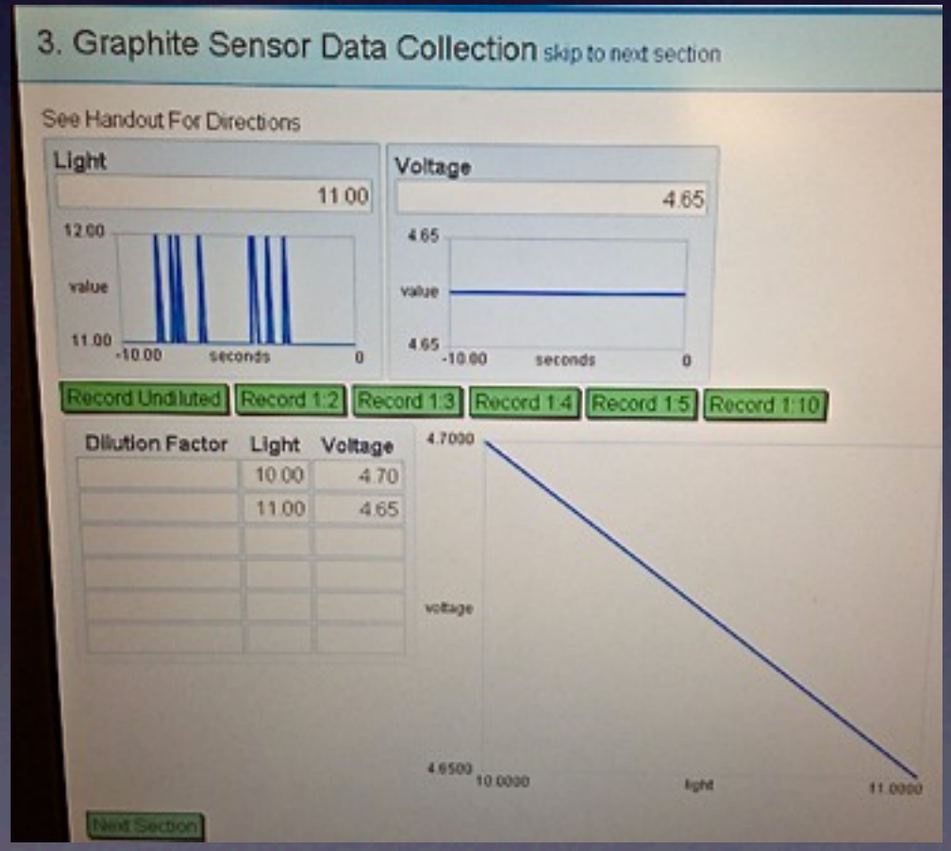
Light Box



Arduino Set Up

Preparation:

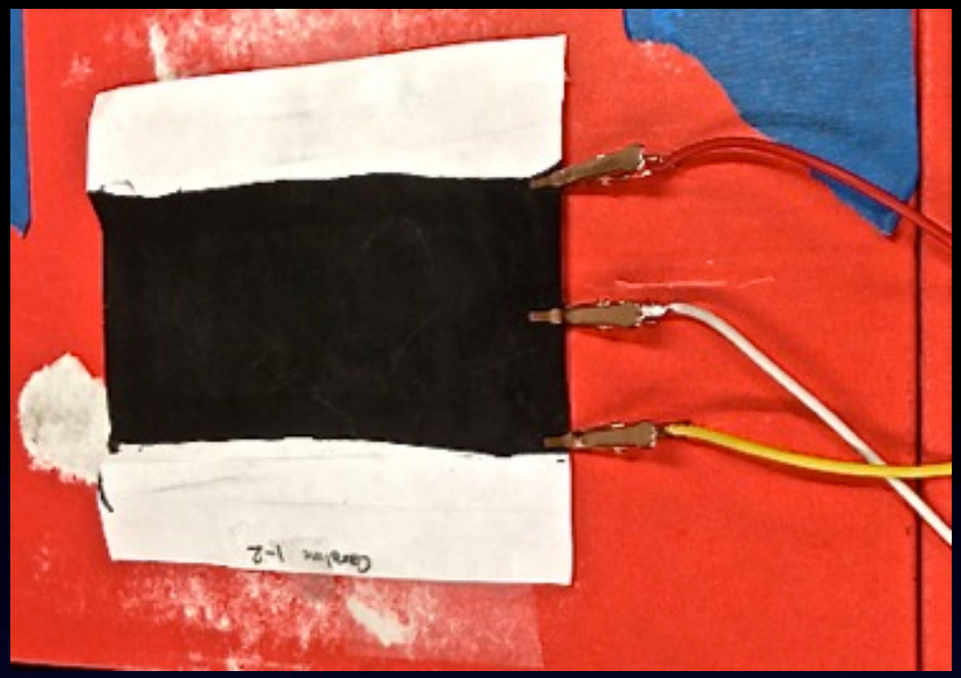
Four Dilutions, two beakers per dilution by yourself = 20 minutes	Light Box Setup: I used a box 6”x10”x2.25” with ~ 1”x2” slot cut out at top and bottom, with a “tail” to set light sensor	Arduino Uno/Mega with Grove shield, and screw terminal to attach three alligator clips for your voltage sensor + connection for light sensor

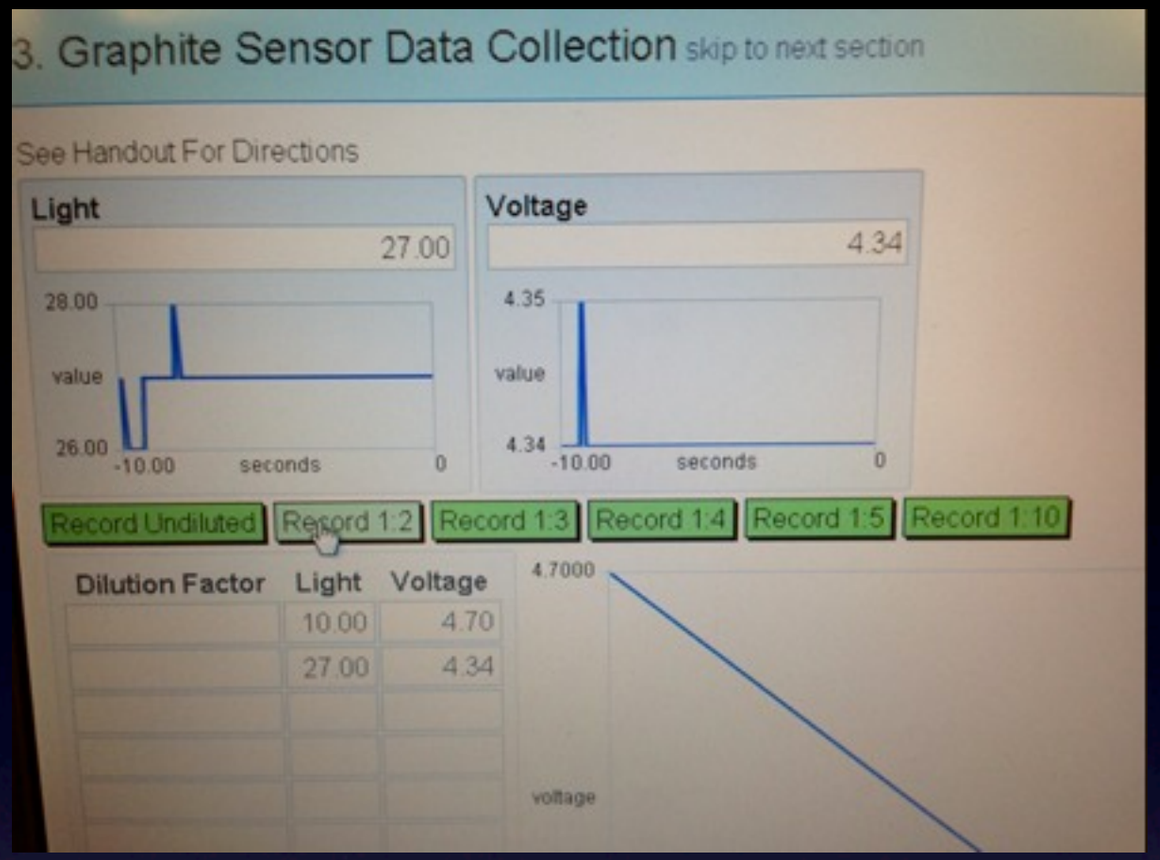


ManyLabs

And...

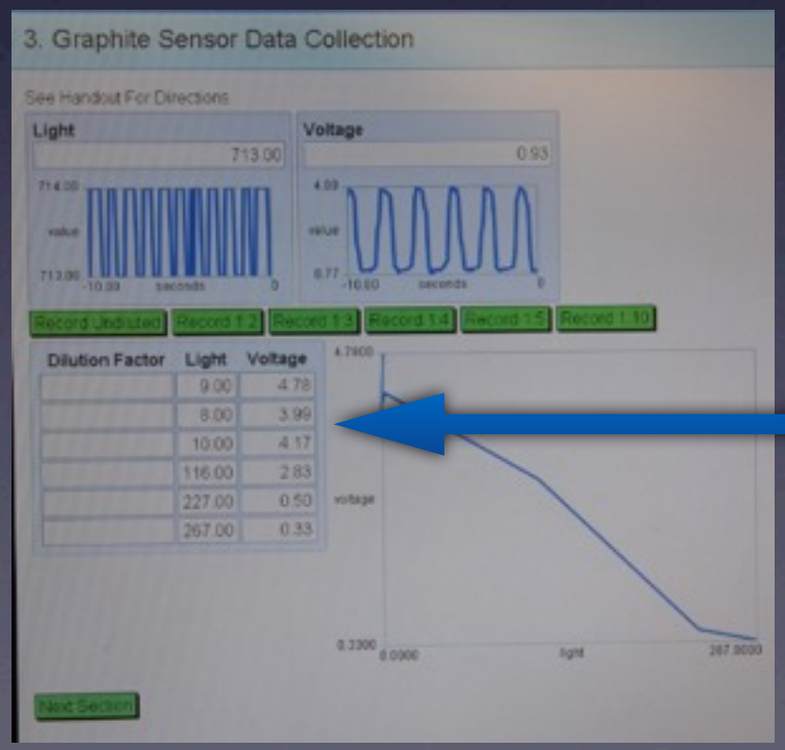
Using an online software interface like ManyLabs www.manylabs.org





Example: Clearly marked "potentiometer" and sample ManyLabs reading

Results after five readings:



Note: Have a backup set of "control" painted strips so students can trouble shoot what went wrong if it didn't work

Possible Problem with results: Make sure students clearly label dilutions!

Lesson #4: Using a CNC as an Autosampler

Goal: To learn how to set up a complex experiment, collect data, and interpret that data.

Equipment:

Open Source Desktop CNC Machine: ShapeOko
Designed by Edward Ford

Atlas Scientific Dissolved Oxygen Sensor

Water samples

Lesson #4: Using a CNC as an Autosampler

Goal: To learn how to set up a complex experiment, collect data, and interpret that data.

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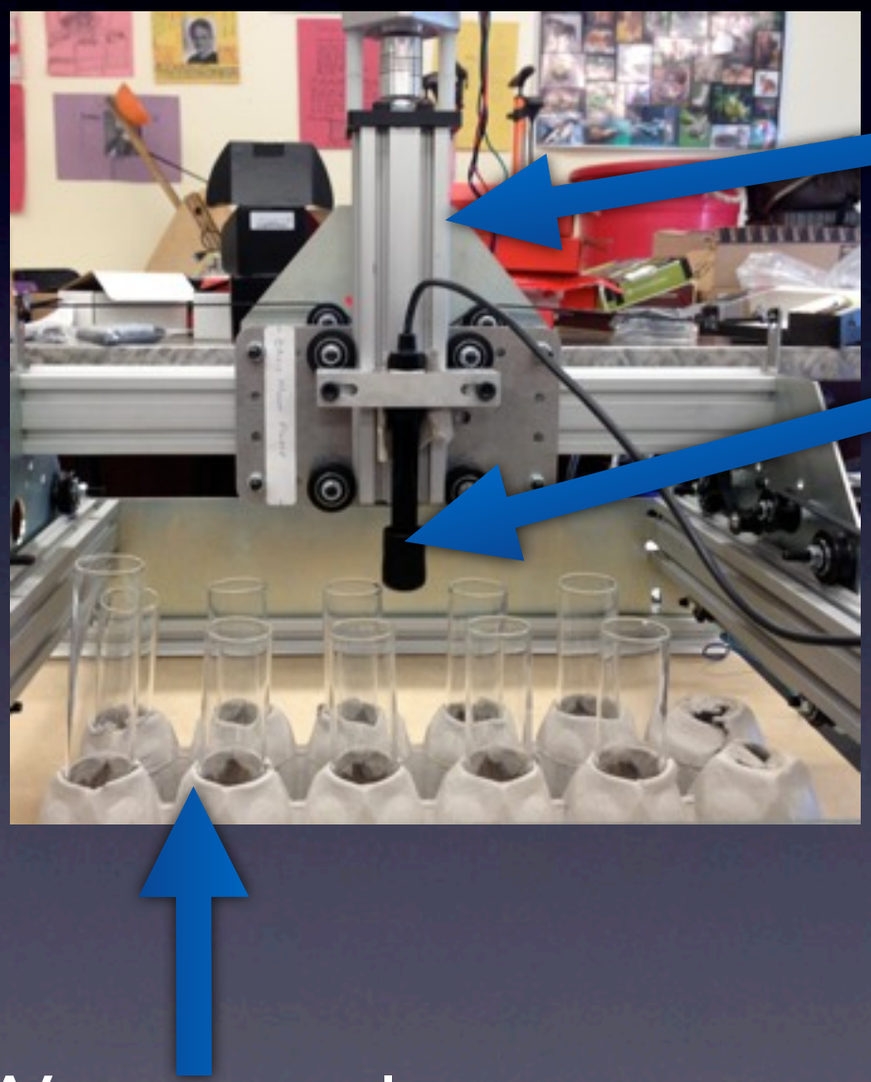


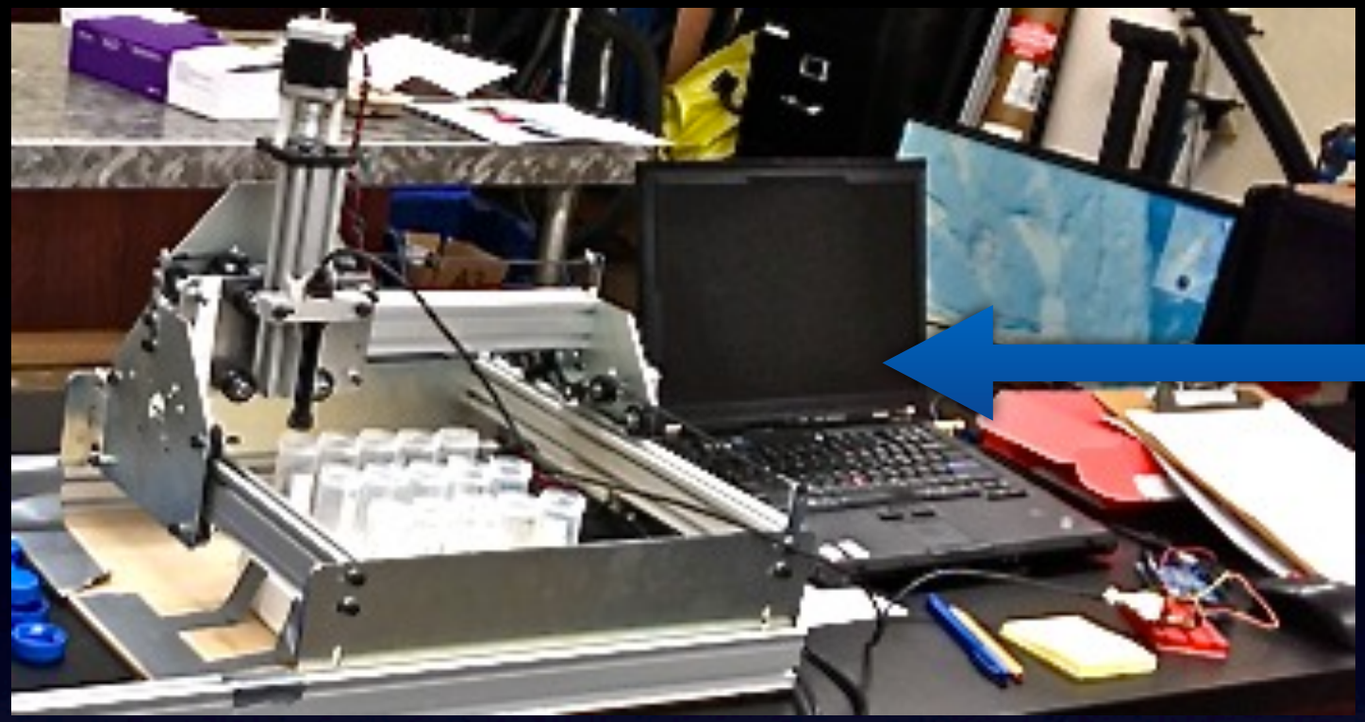
Open Source Desktop CNC Machine: ShapeOko
Designed by Edward Ford

Atlas Scientific Dissolved Oxygen Sensor

Water samples

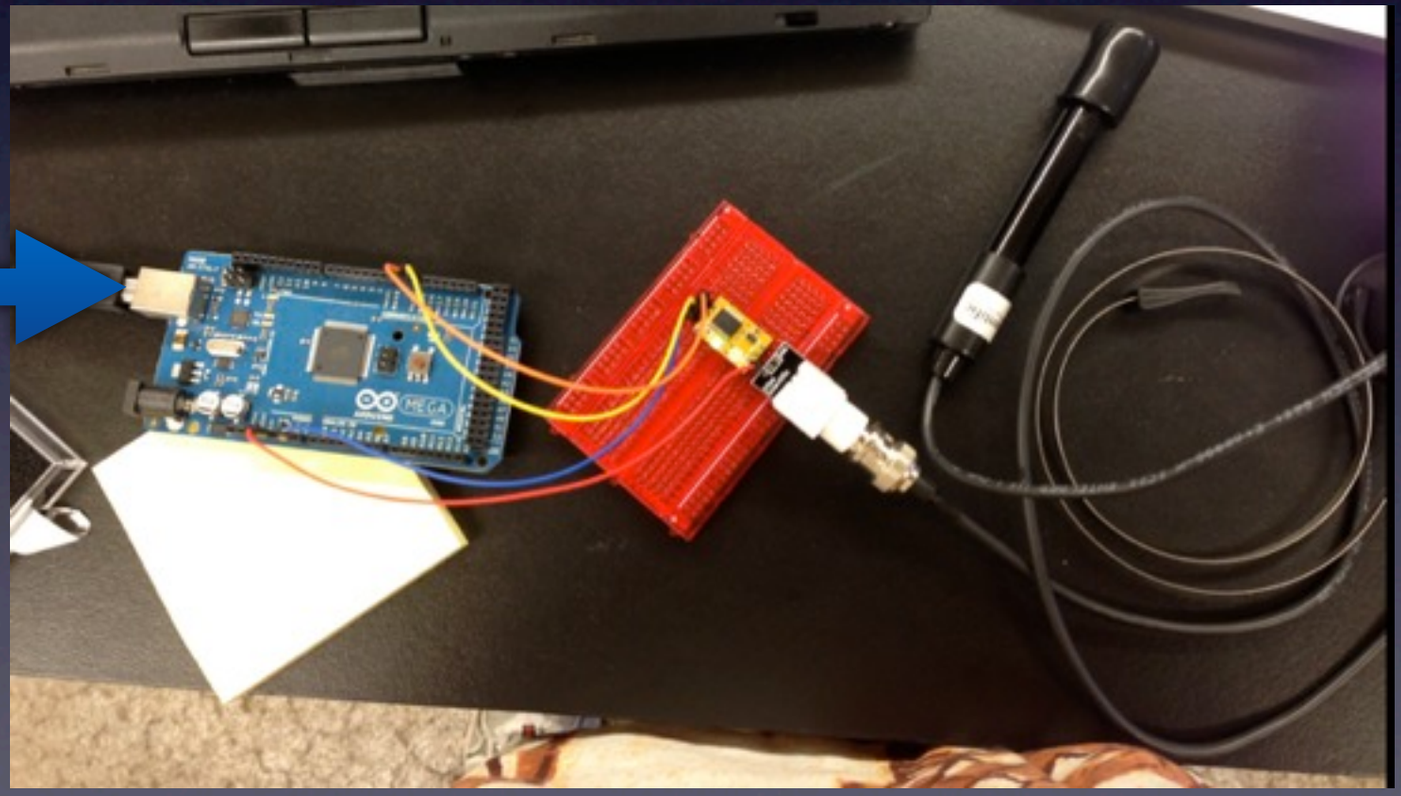
Trouble Shooting:

1. Mount for D.O. Sensor
2. Plotting x, y, z for all samples
3. Eccentricity of Z axis rod causes problems with programming gcode for smooth run
4. Getting D.O. Sensor to read
5. Calibrating D.O. Probe
6. Collecting Data



Laptop to run CNC & D.O. Probe

Atlas Scientific Dissolved Oxygen Sensor with Arduino Mega wiring



Thank you

Dr. Kevin Plaxco, et al
Adriana Patterson, PhD, Mentor
Dr. Frank Kinnaman, MRL
Peter Sand, ManyLabs Founder
Edward Ford, ShapeOko
MRL
NSF