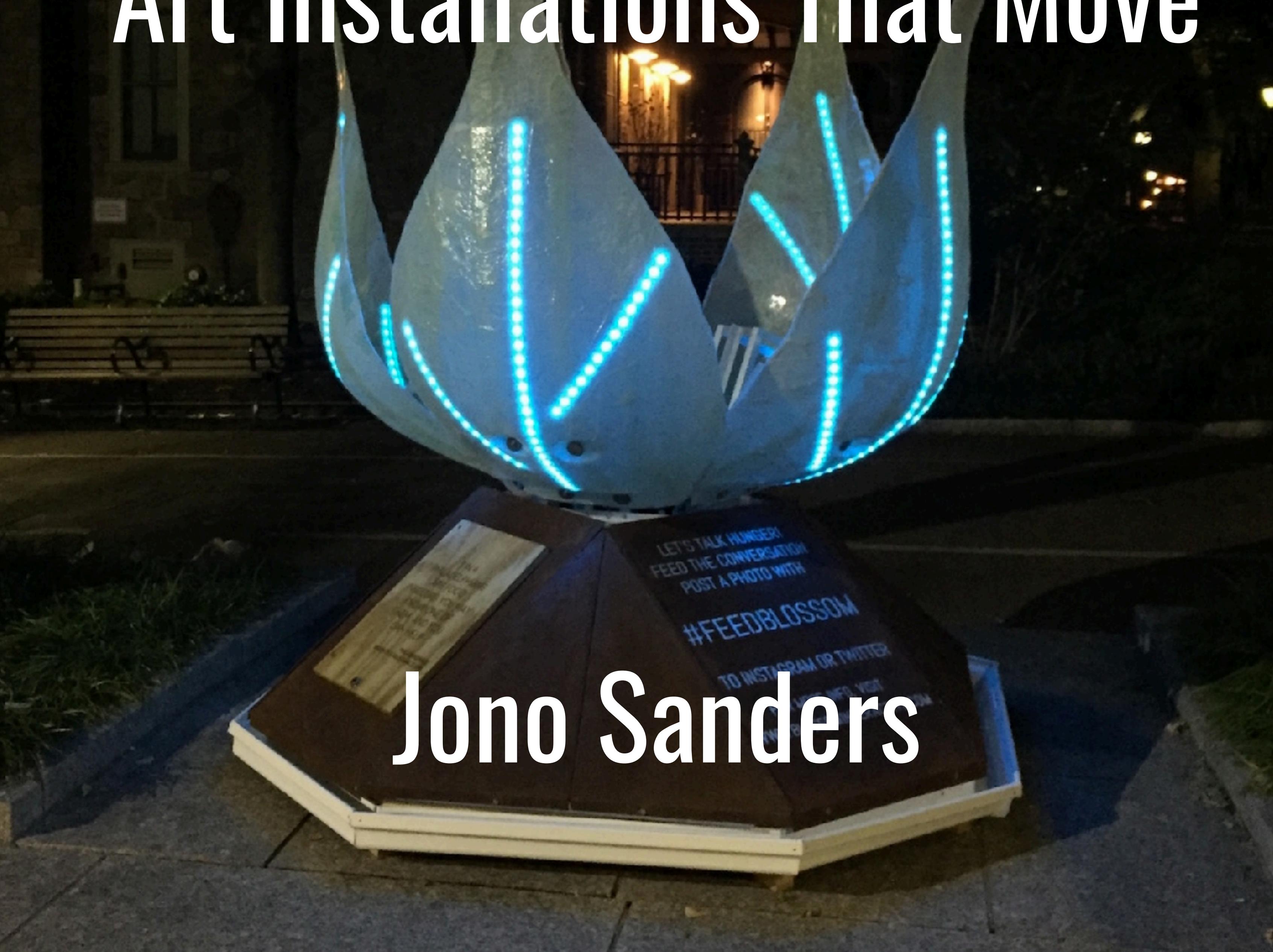


# Art Installations That Move

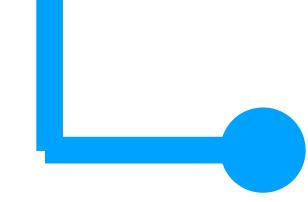
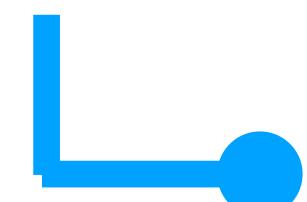


Jono Sanders

# Art Installations That Move

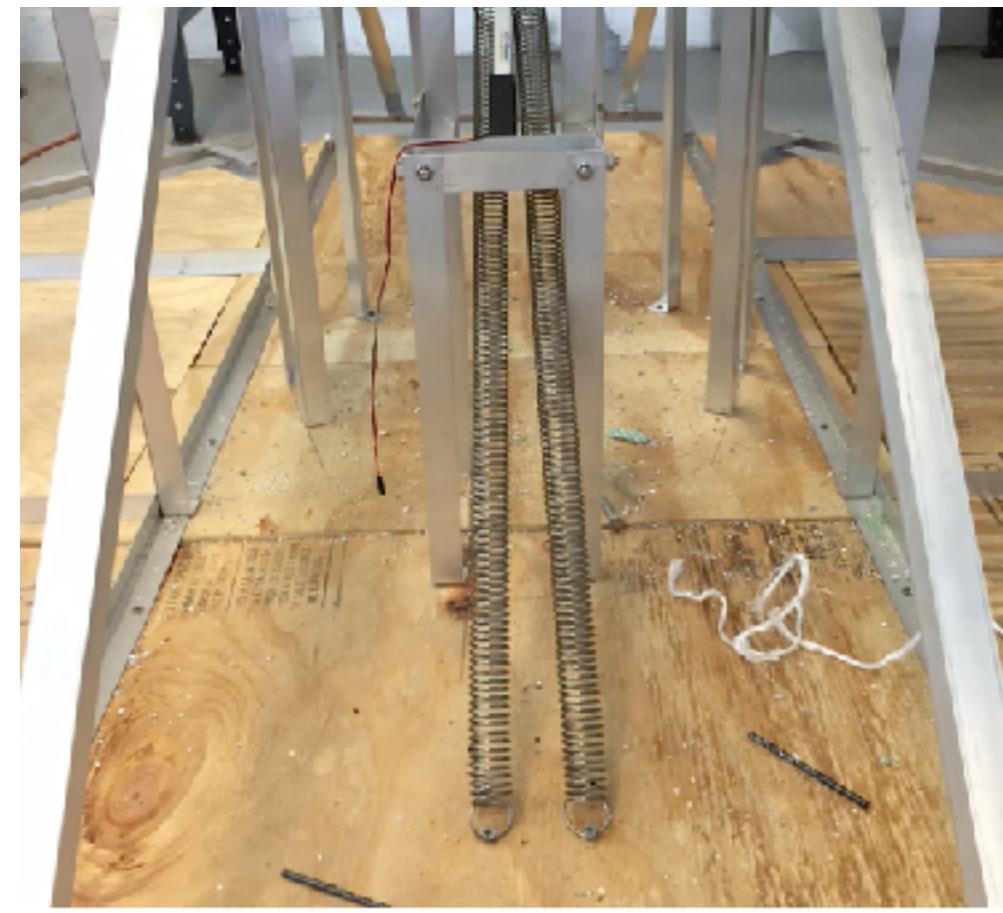
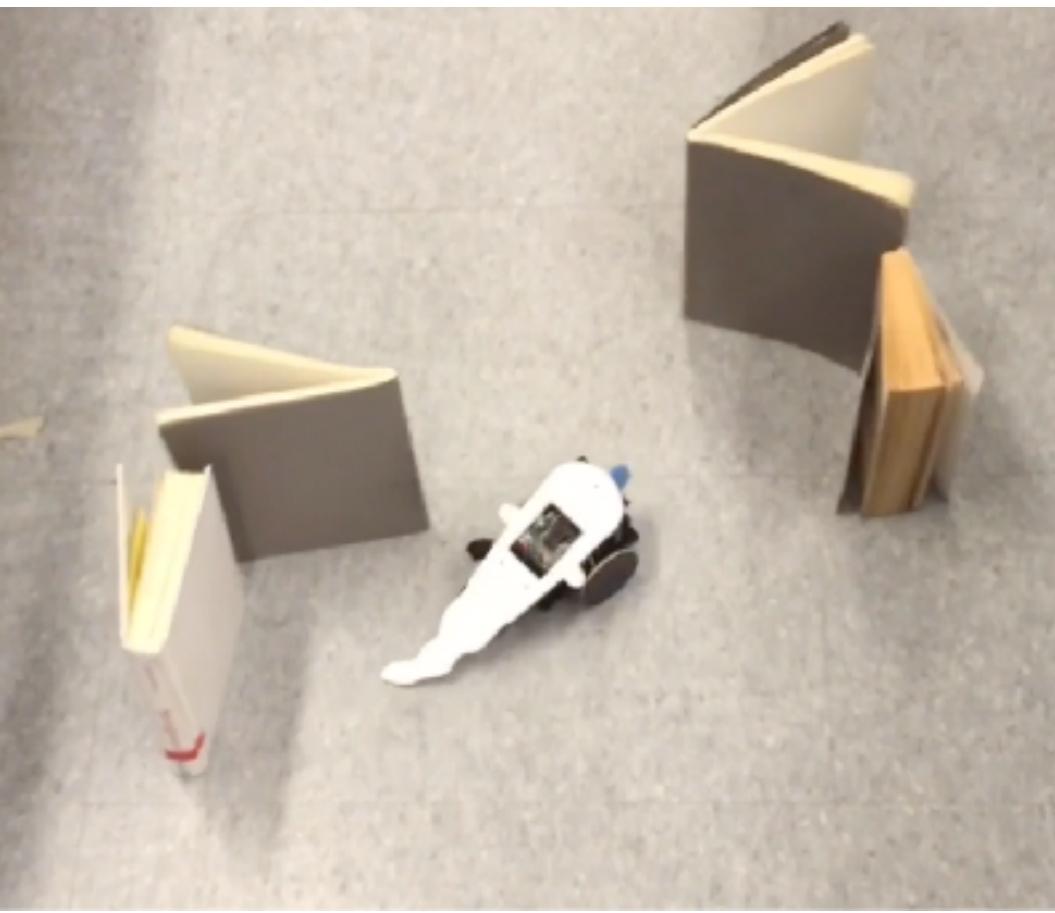
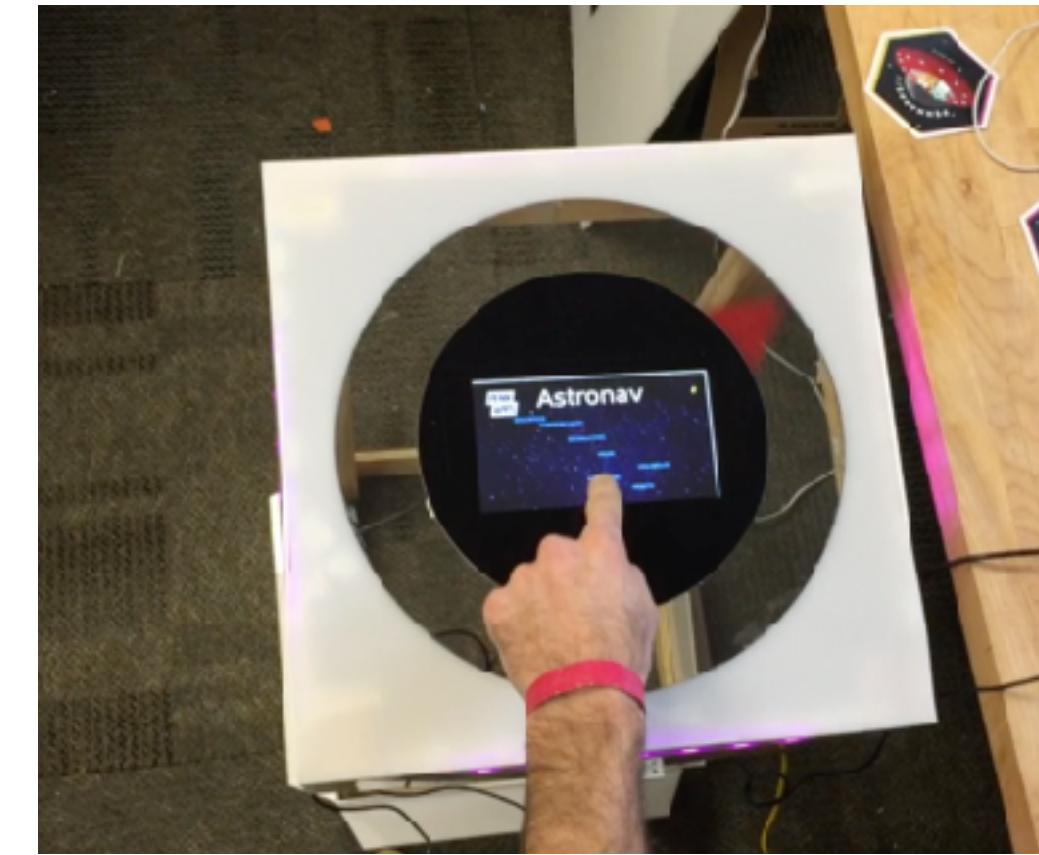
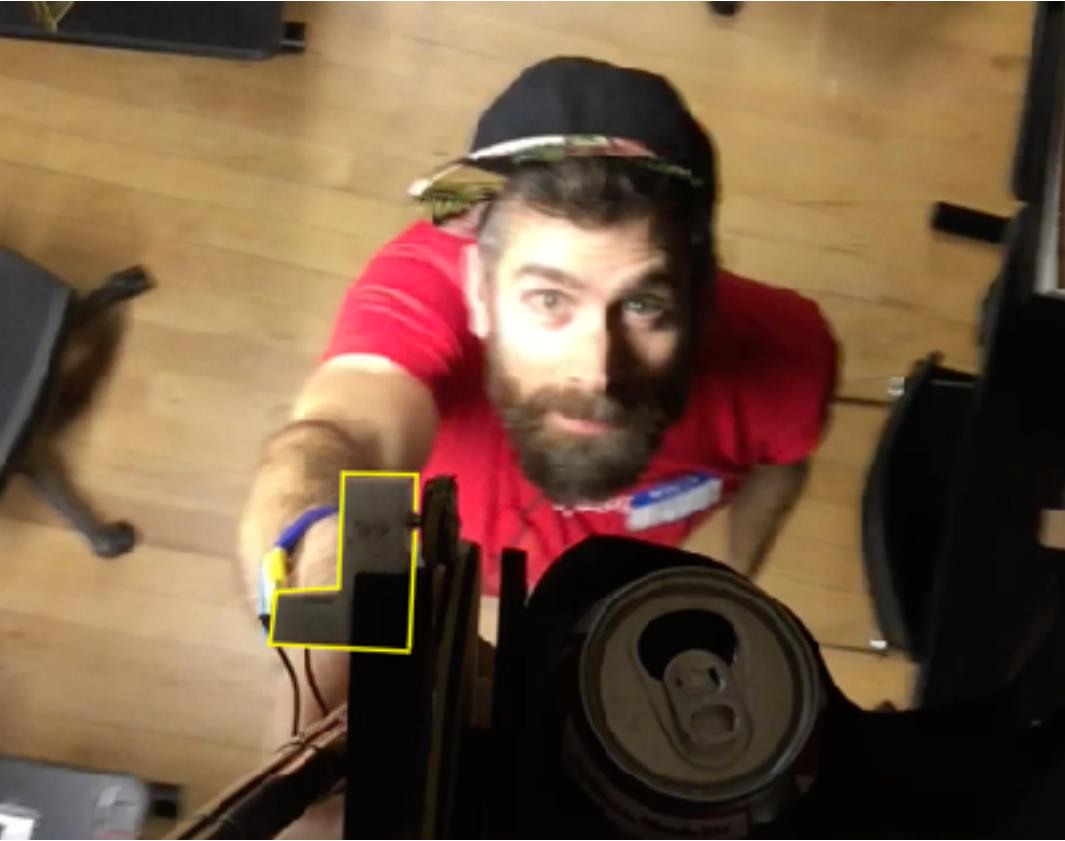
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## Spring, Motors & Gears

-  **Controlling Motors**
-  **Electricity 101**
-  **Powering Motors**
-  **Building & Prototyping**

# Example Projects that Move

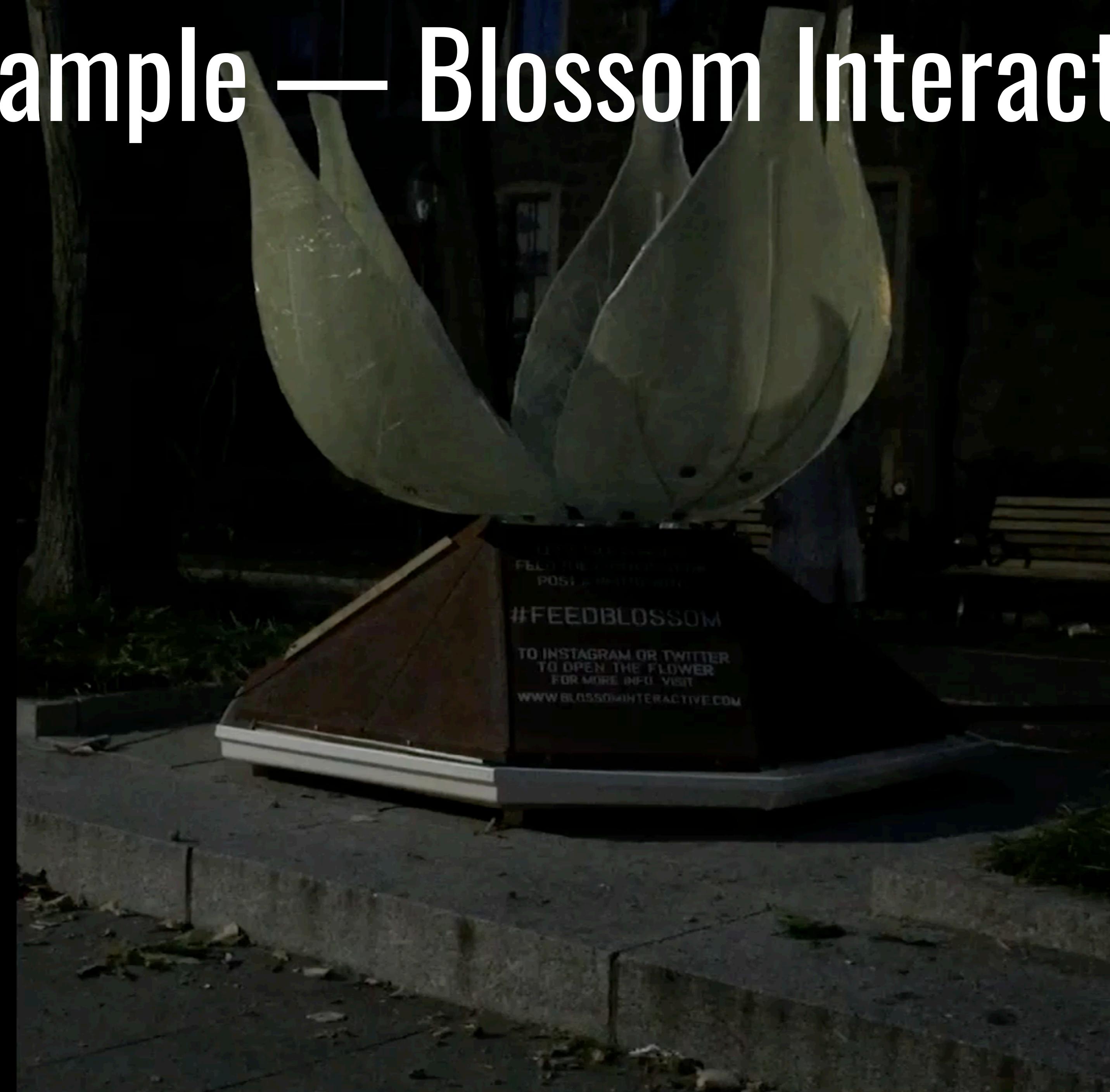
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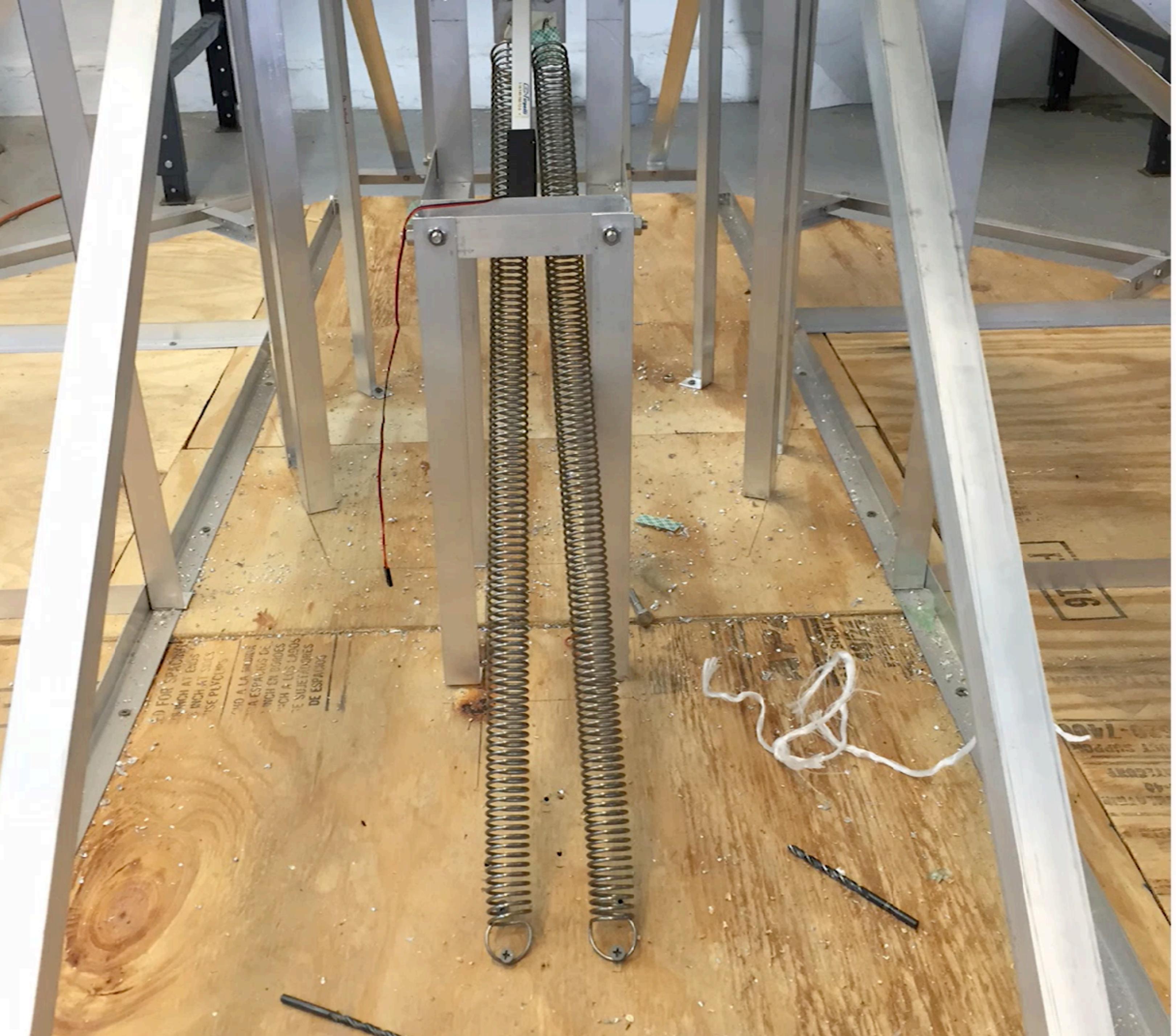


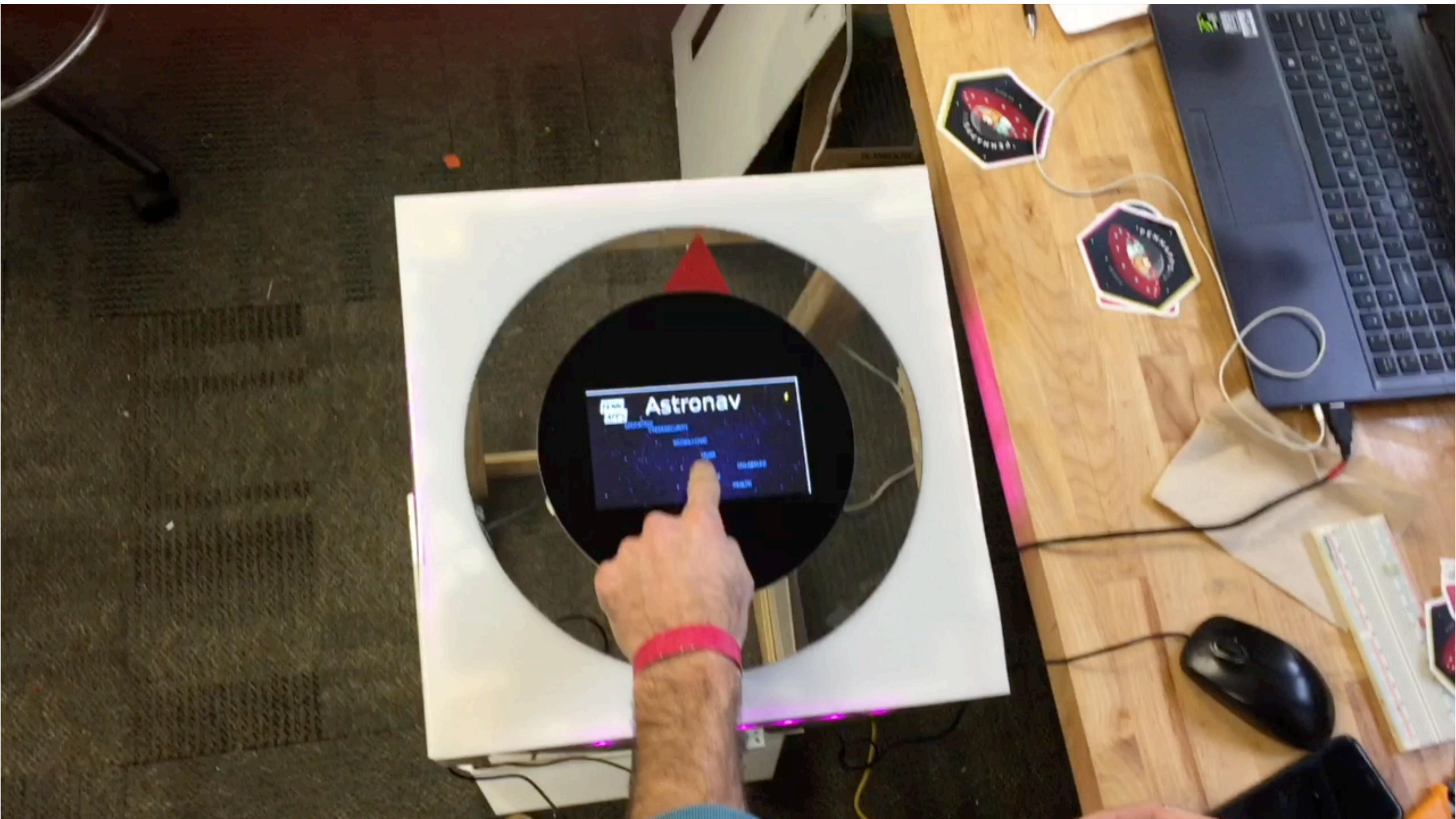




# Example — Blossom Interactive





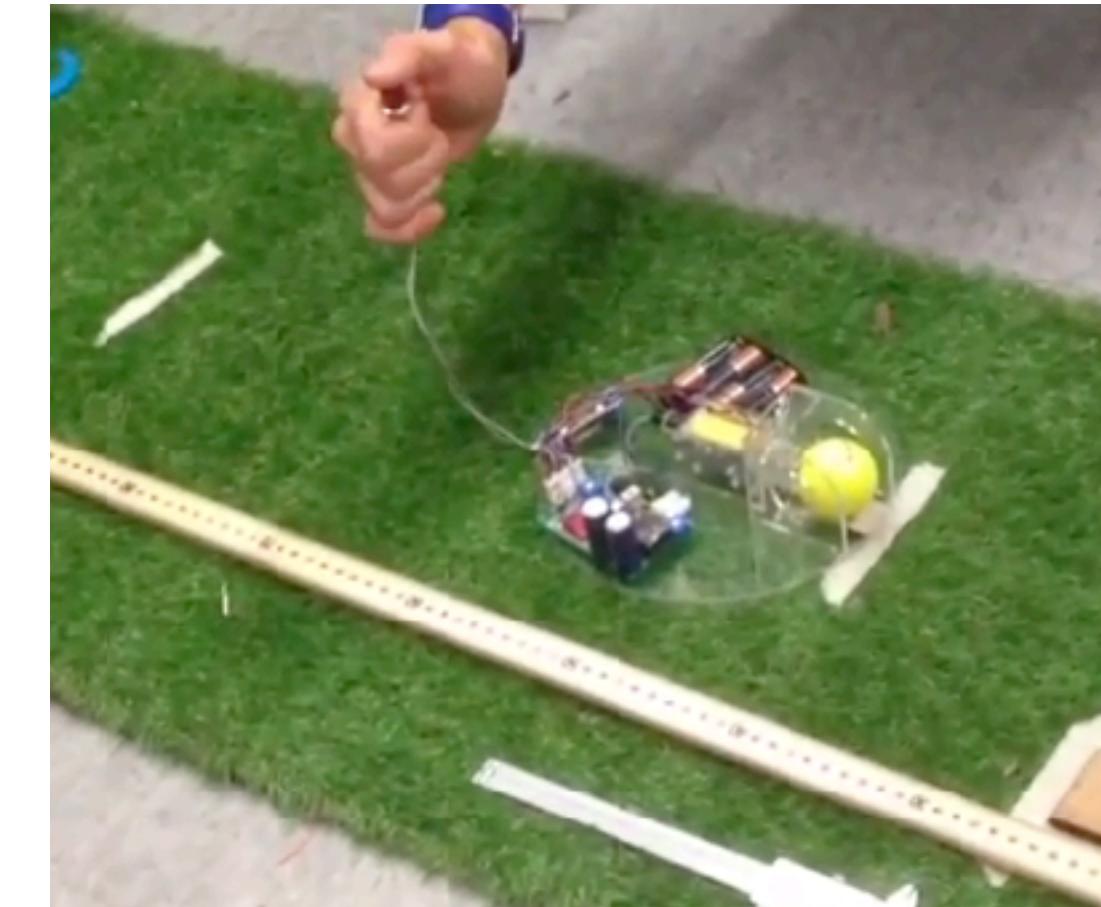
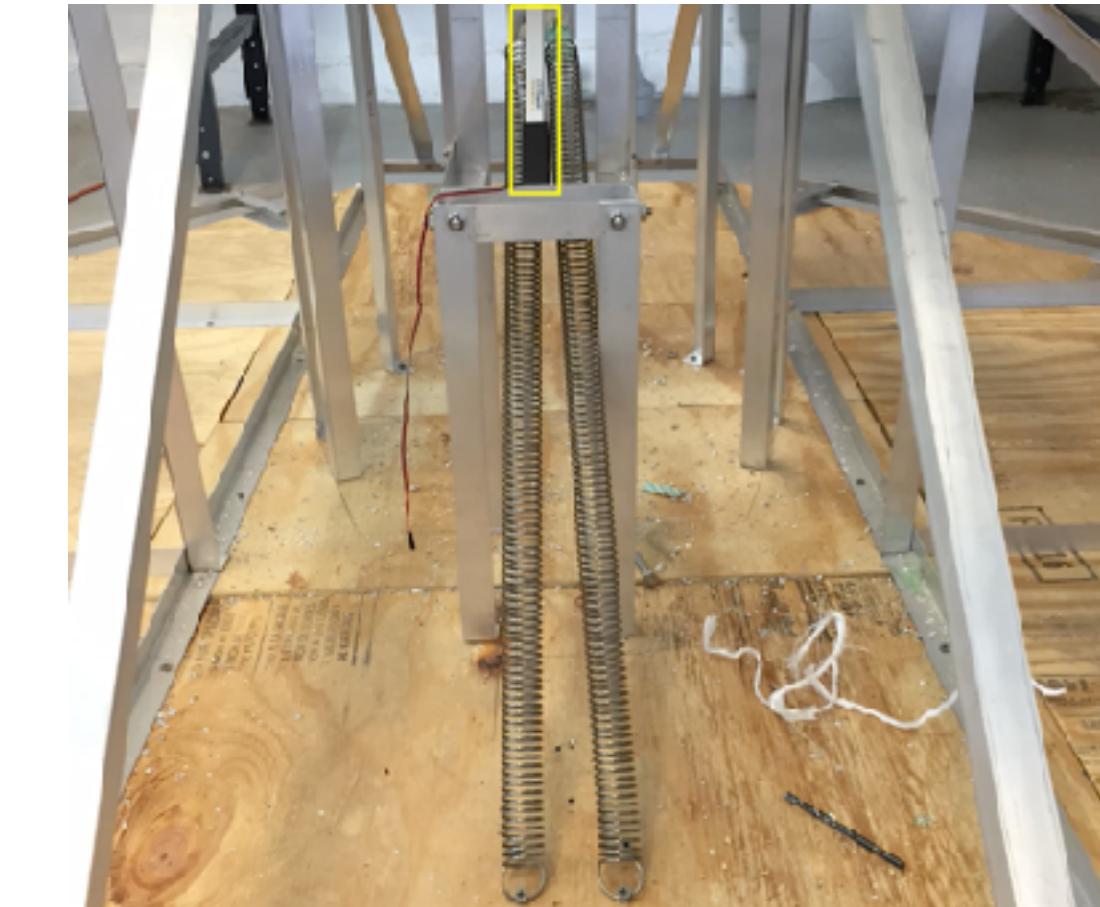
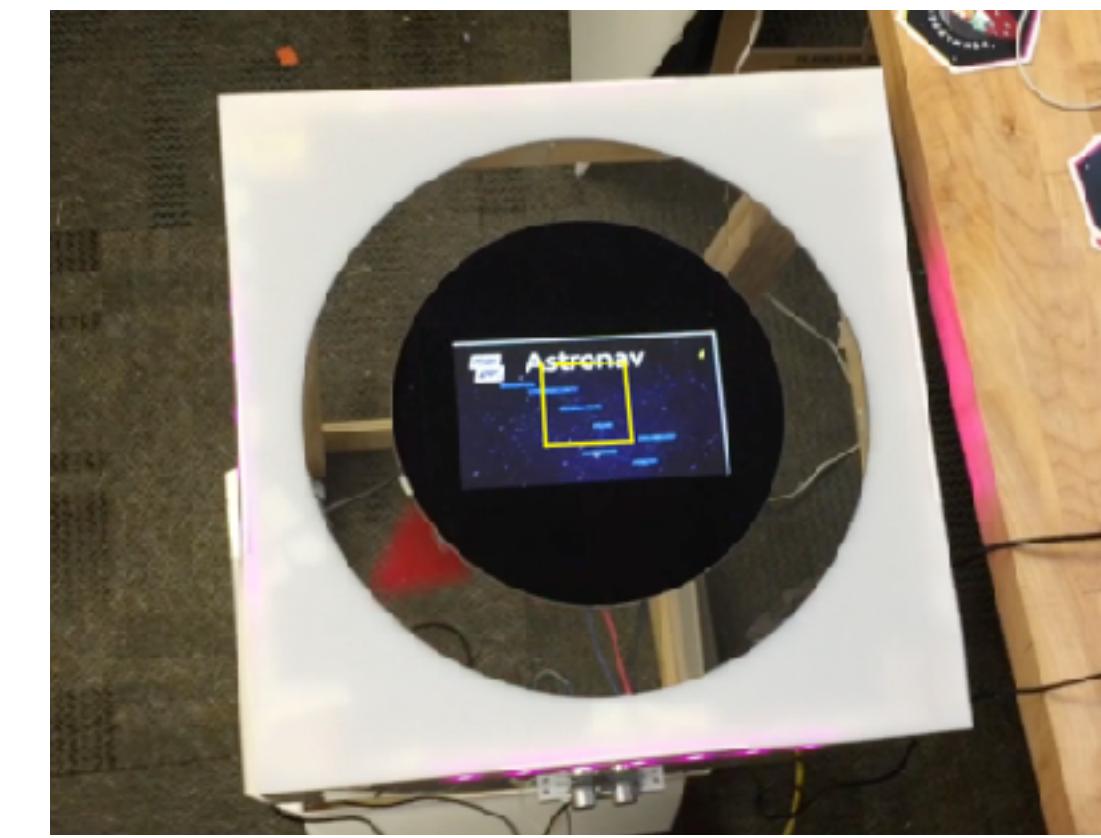
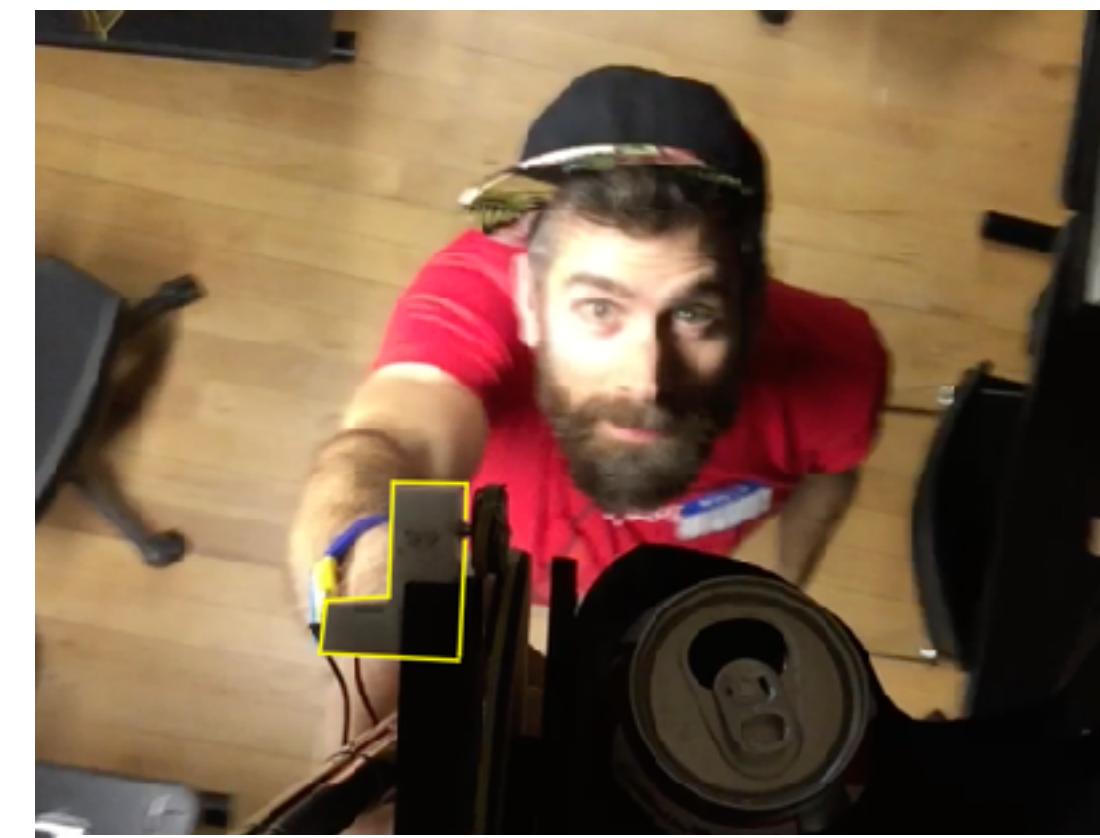




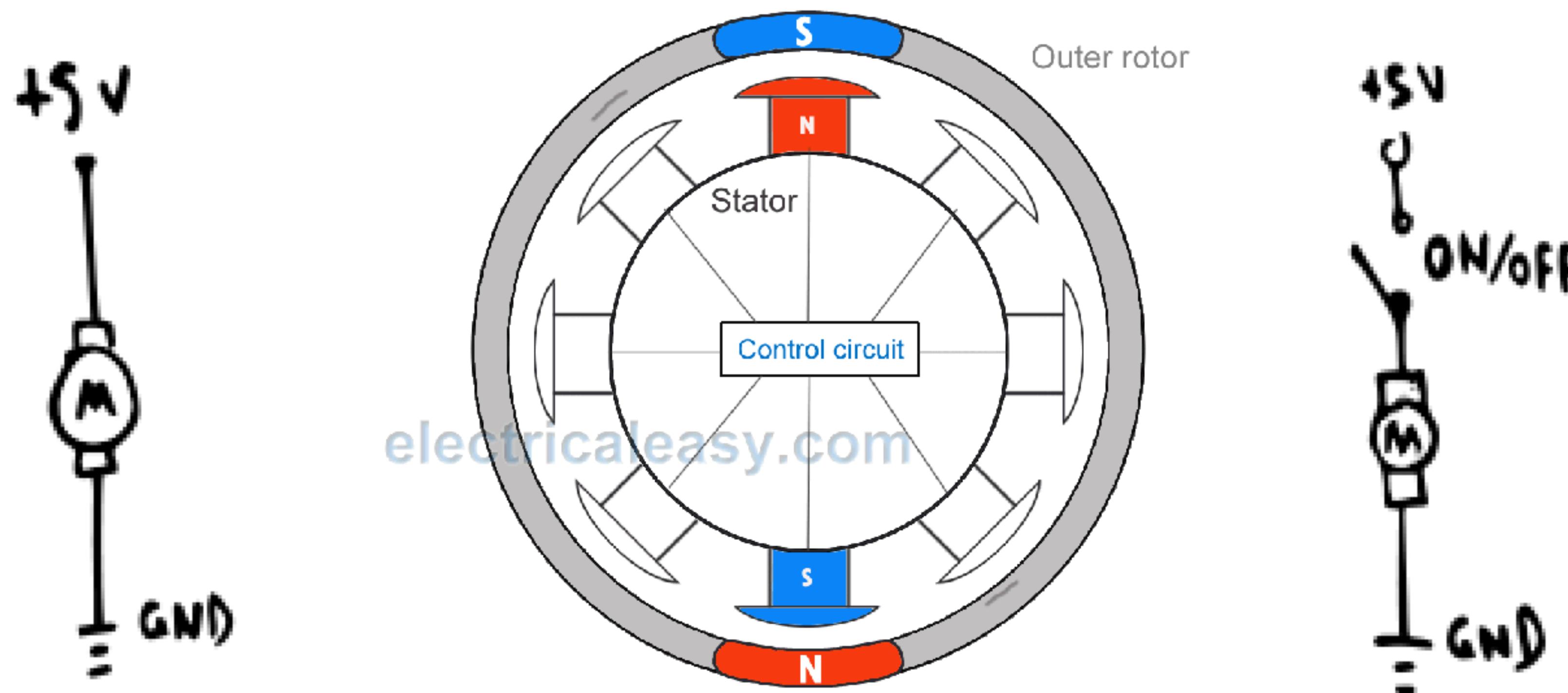
# More ways to move

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- DC Brushless Motor
- Stepper Motor
- Linear Actuator
- Springs
- Pedal Power
- Solenoid



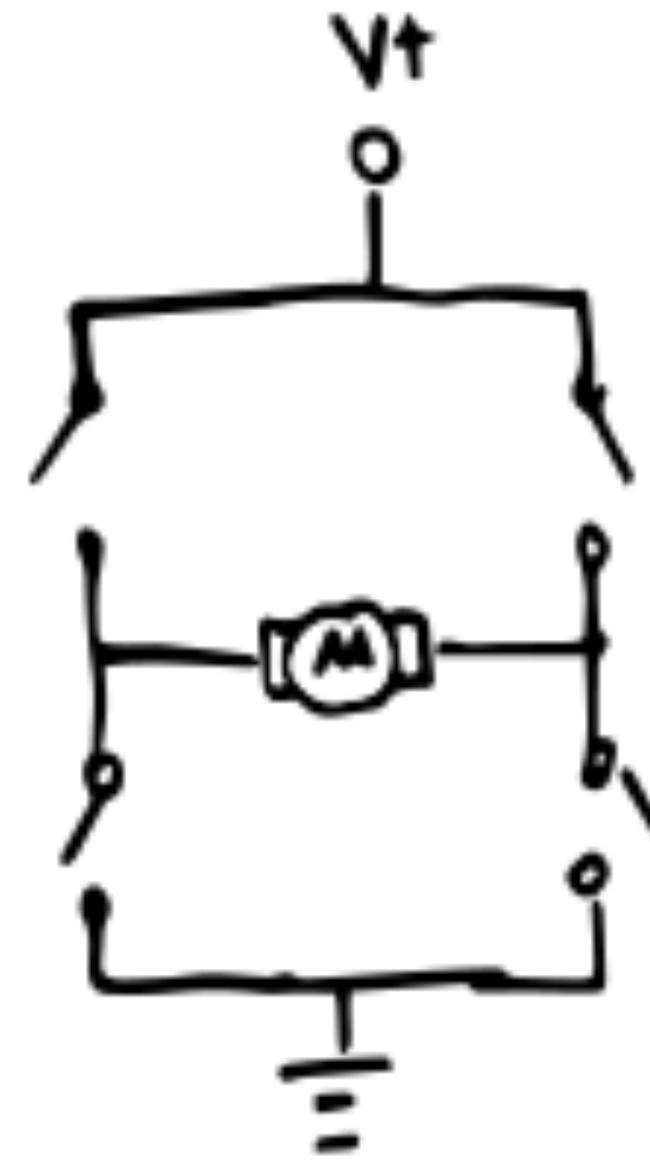
# Controlling Motors



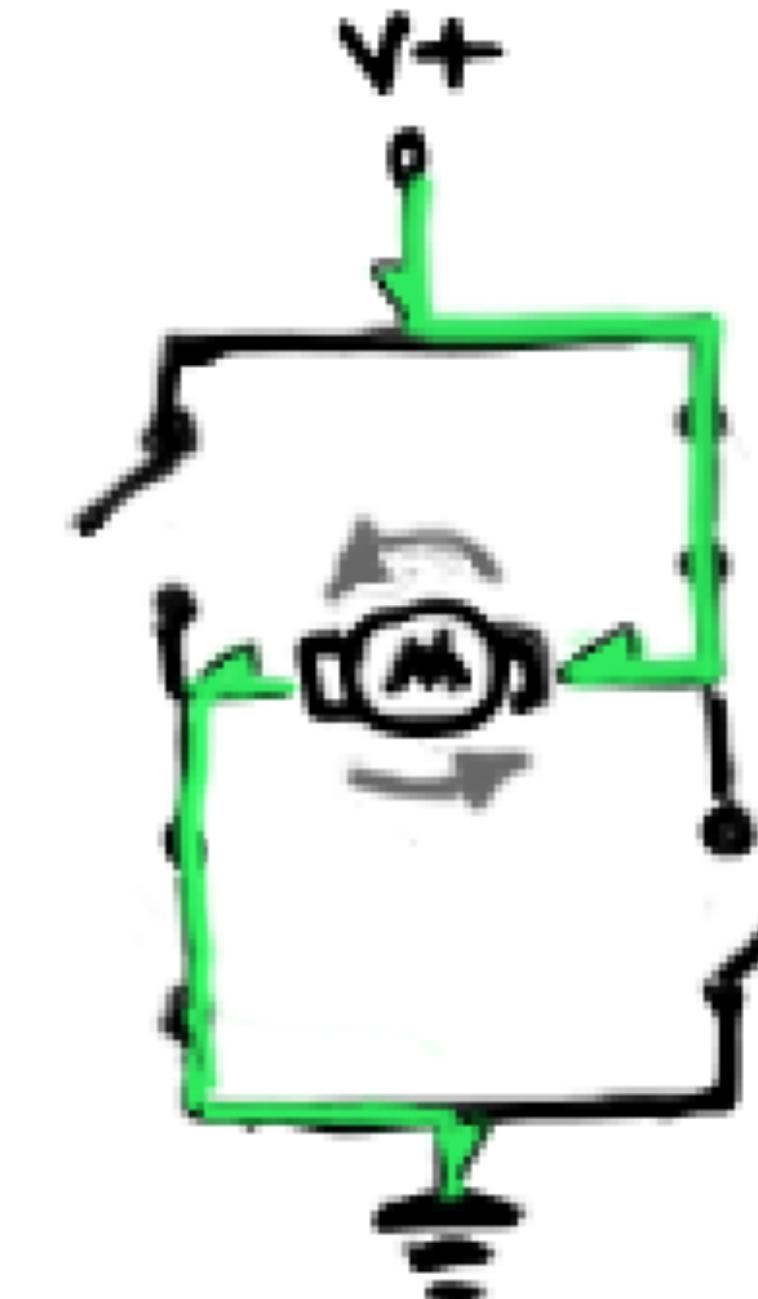
Src: [Electrical Easy](http://electricaleasy.com)

# Motor Directions

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H-bridge



# Electricity 101: Current

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**Current:** a quantity representing the rate of flow of electric charge, measured in amperes (A)

Like water flow, current is the movement of negatively charged particles, called electrons, through a predetermined cross sectional area in a conductor.



# Electricity 101: Voltage

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**Voltage:** electromotive force or potential difference, usually expressed in volts (V).

Like potential energy at a water fall, voltage is the potential difference across two terminals

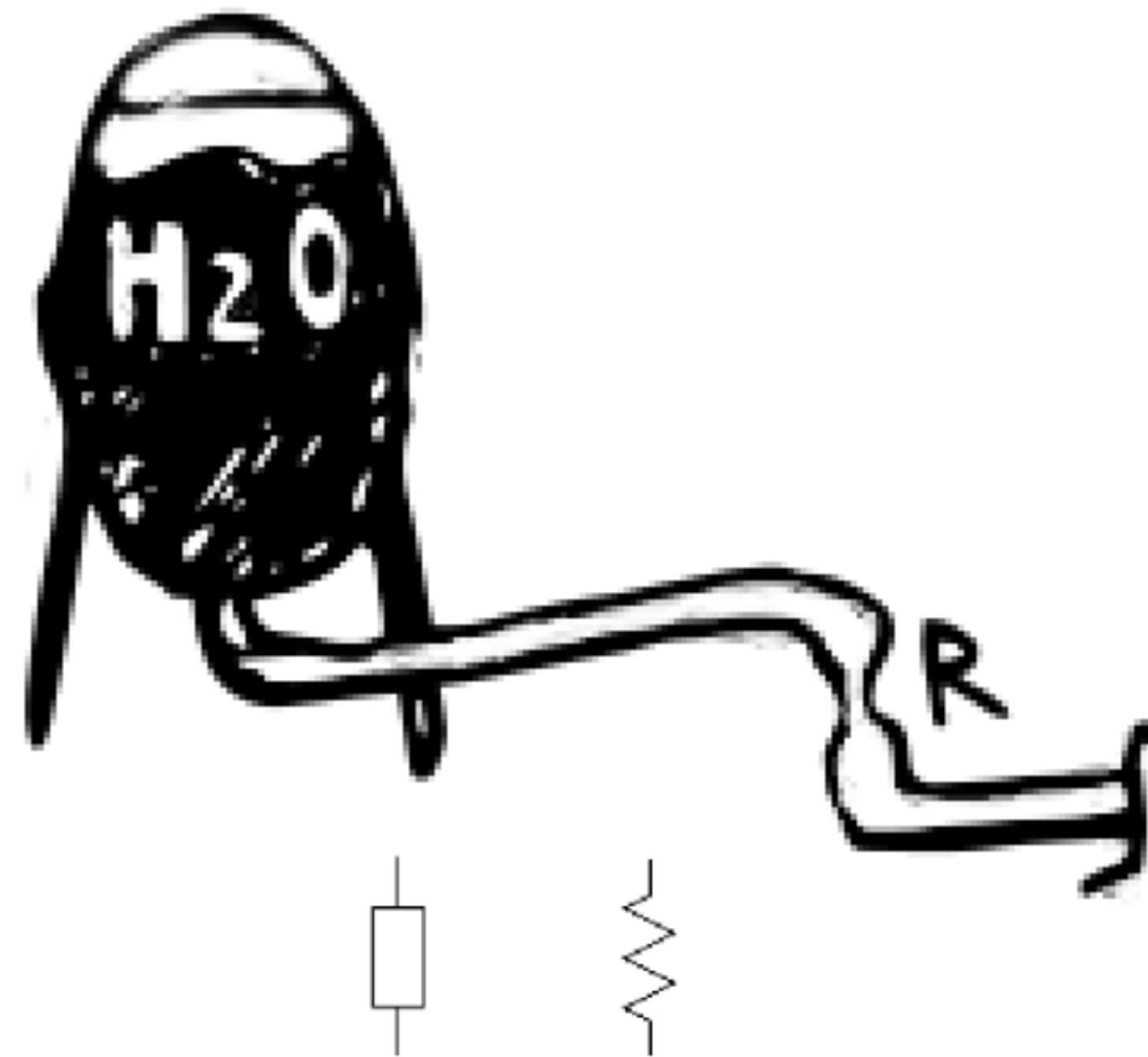


# Electricity 101: Resistance

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**Resistance:** the degree to which a substance or device opposes the passage of an electric current, measured in ohms ( $\Omega$ )

The resistance of a material is often used to control electric current flow



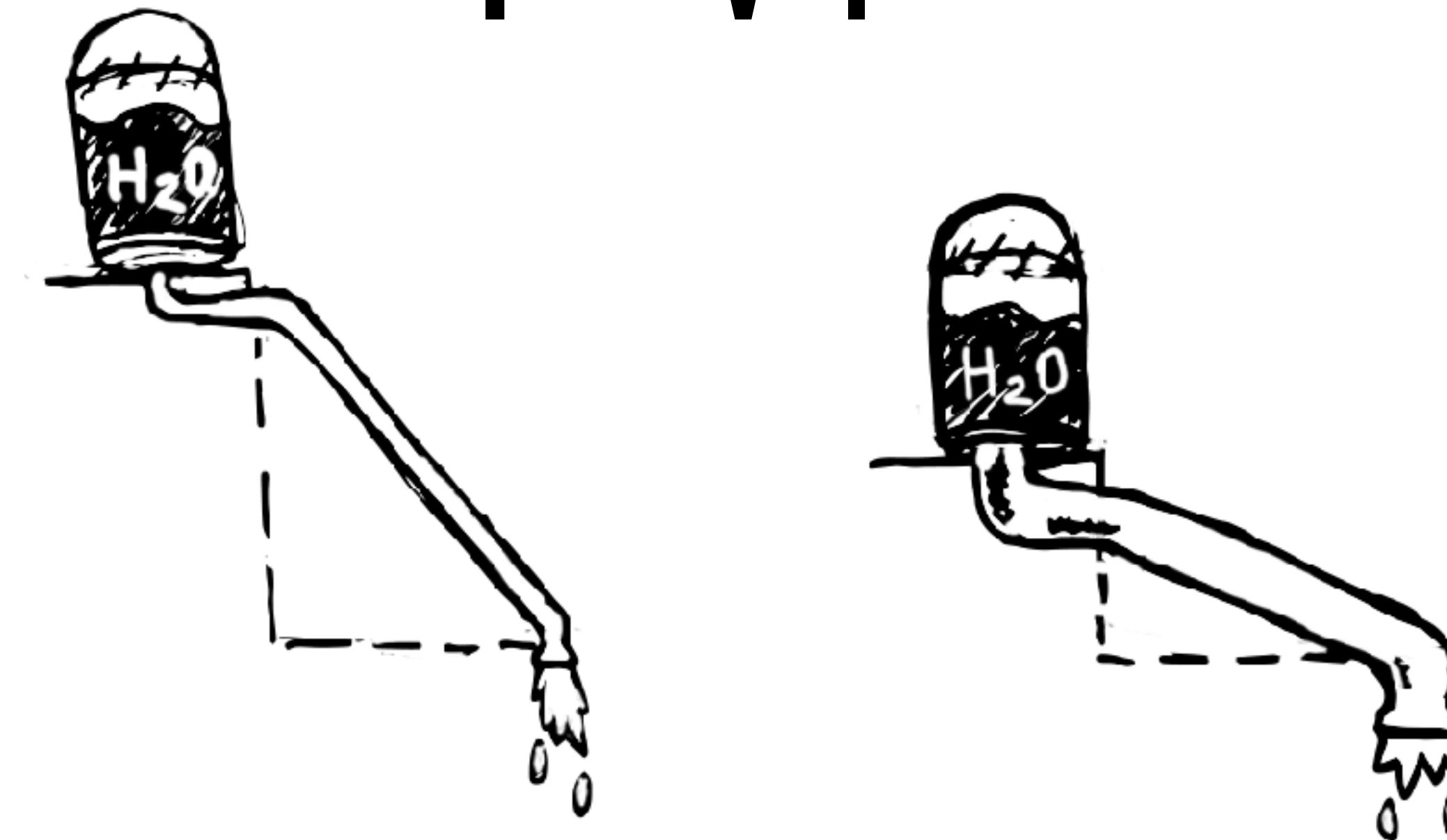
Resistor Symbol

# Electricity 101: Power Formula

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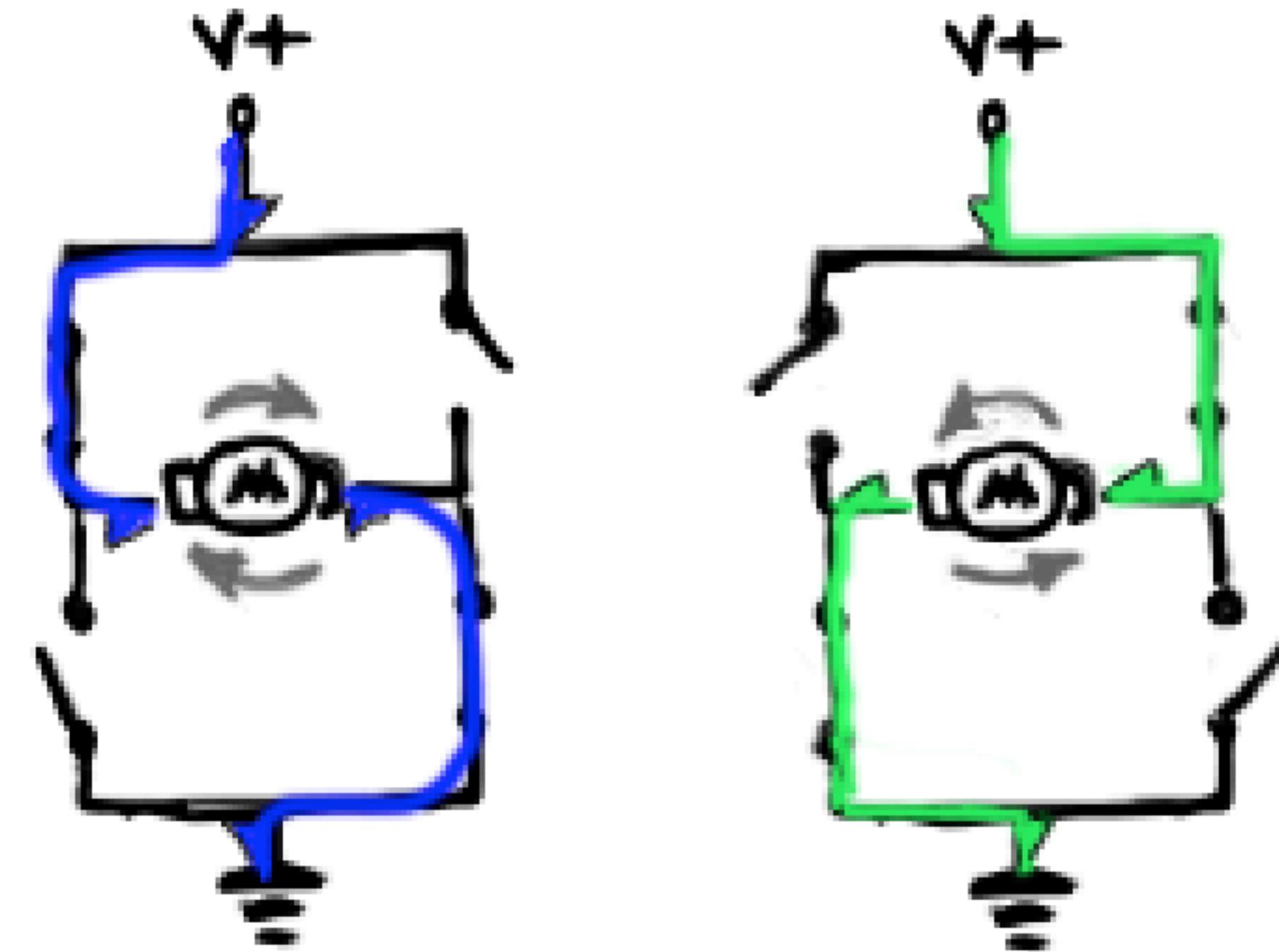
**Power** : the amount of energy transferred per unit time, which for electric power is often expressed in Watts (W).

$$P = V \cdot I$$



# Motor Directions

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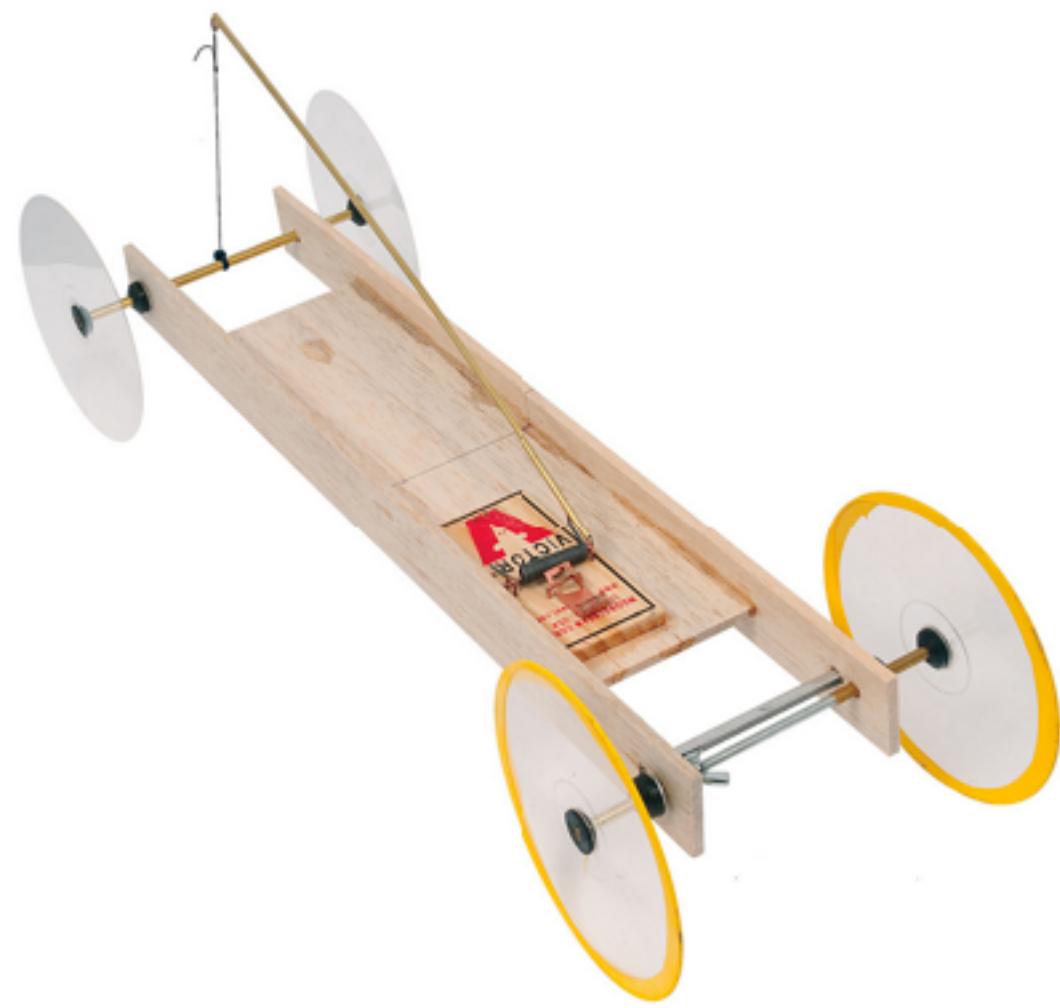


Why does this matter? – Let's see an **H-bridge** example!

# Powering Motors — Options

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**Springs / Mouse trap**

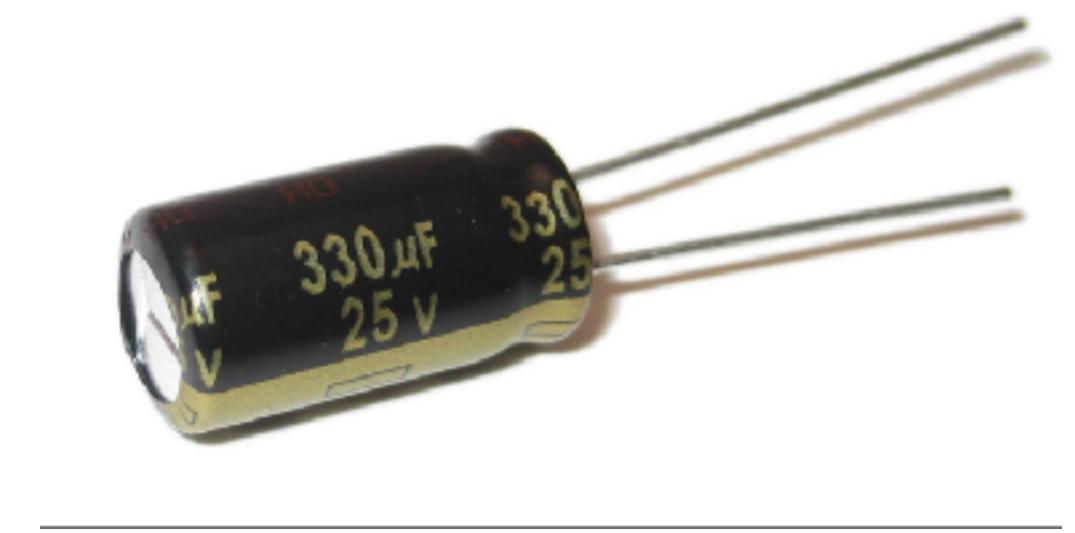


**Batteries**

**Power Supplies**

**Power Converters**

**Capacitors**



# Motor Selection

CircuitSpecialists Search circuitspecialists.com

## NEMA 14 Stepper Motors

Filter Availability In Stock

Availability	Product Image	Product Description	Price
In Stock		0.5 kg-cm 4 Wire NEMA 14 Stepping Motor Item #35BYG101 \$8.95	
In Stock		0.5 kg-cm 4 Wire NEMA 14 Stepping Motor Item #35BYG202 \$12.95	
Out of Stock		1.0 kg-cm 4 Wire NEMA 14 Stepping Motor Item #35BYG305 \$9.50	

## Nema 14 Stepper Motor

12V, 400 mA  
(4.8 W)

www.pololu.com

### Pololu Metal Gearmotors

Compare

This wide selection of brushed DC metal gearmotors lets you choose the optimal torque and speed for your particular application. These motors are available in a variety of sizes and gear ratios.

**Pololu GM 12A**  
6V, 240 mA  
(1.44 W)

Home > Products > L16 Micro Linear Actuators & Servos >

### L16-S Miniature Linear Actuator with Limit Switches

**ACTUONIX**

Price: \$70.00  
Product Code: L16-S

Choose your options

Stroke  
Actuator Stroke

L16-S Miniature Linear Actuator with Limit Switches  
Larger Photo

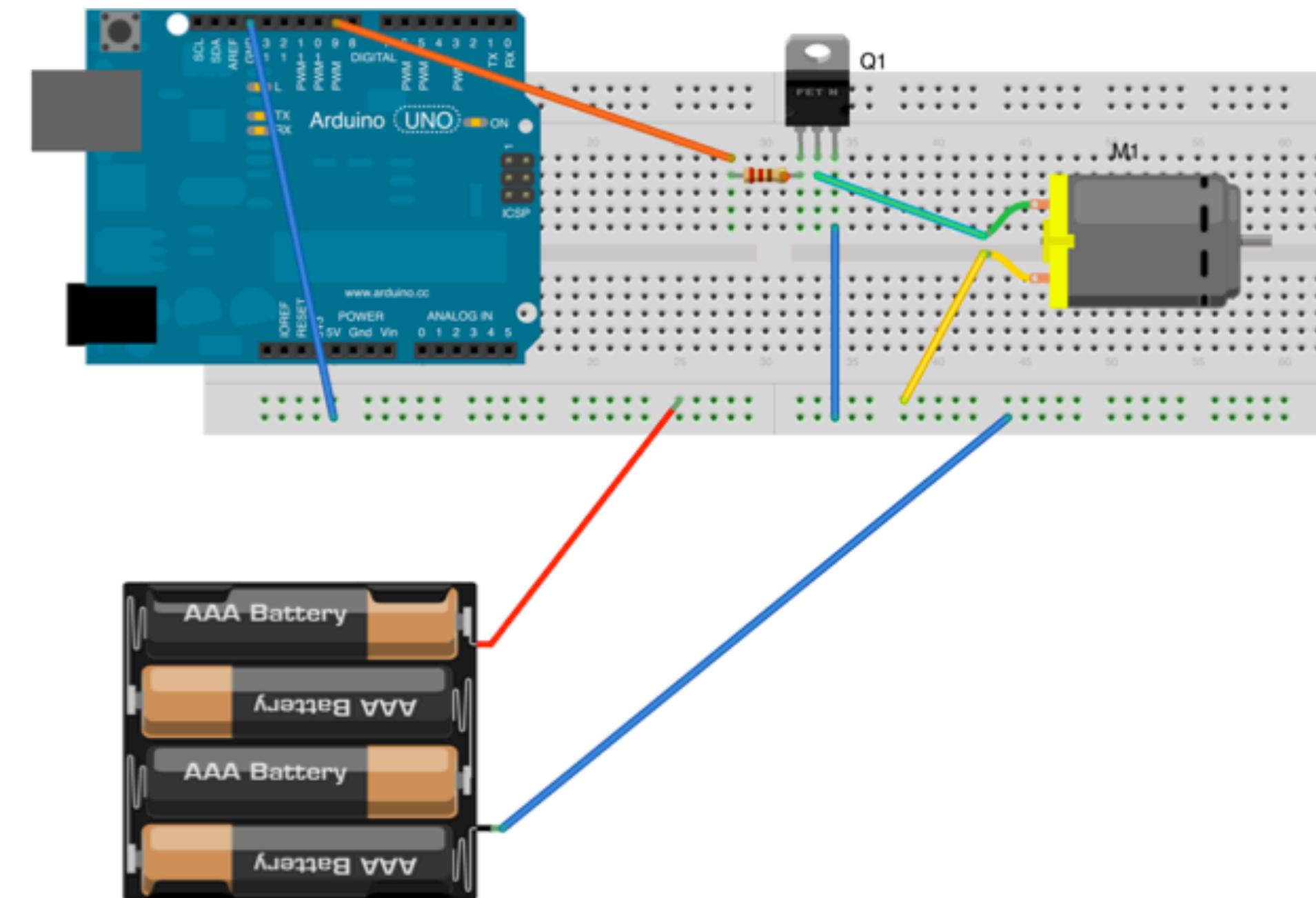
## Firgelli L16-S Linear Actuator

Stall Current: 12V, 650 mA  
(7.8 W)

# Powering Motors — Circuits

# Don't burn out your micro controller!!

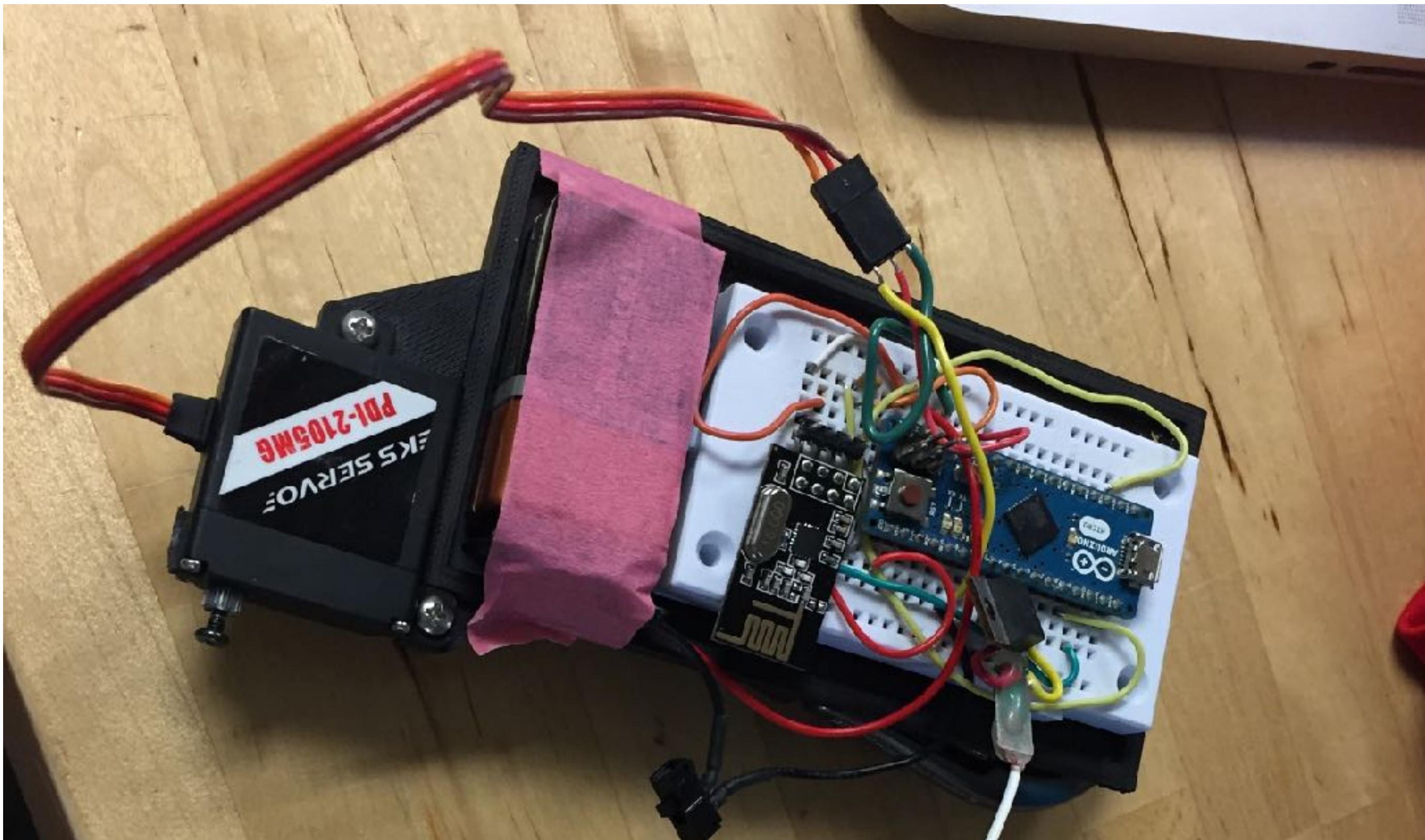
- a) Use a motor driver board
  - b) Build a MOSFET circuit



Src: OddWires.com

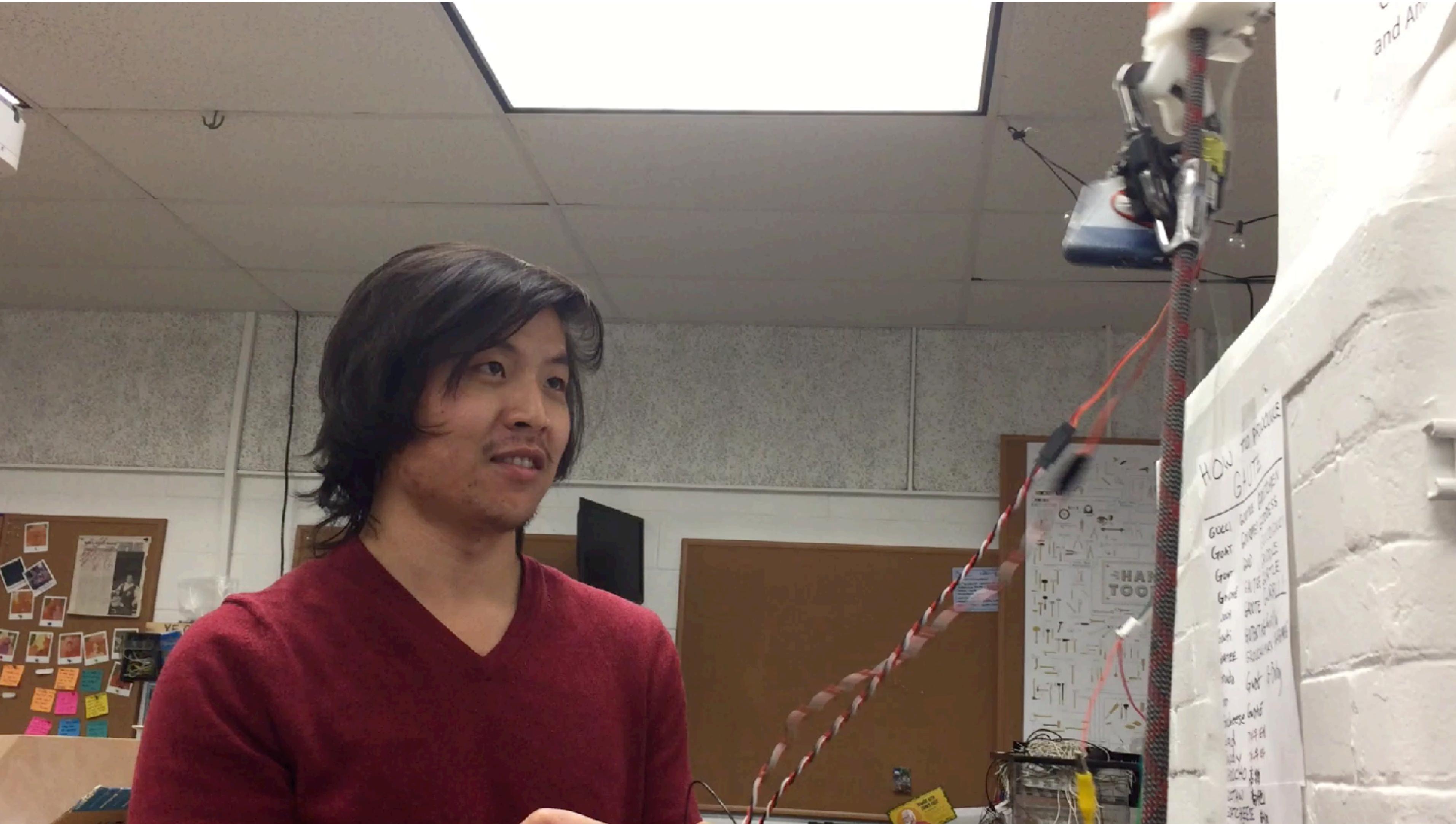
# Prototyping + Testing

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Let's see another example with a solder less breadboard!

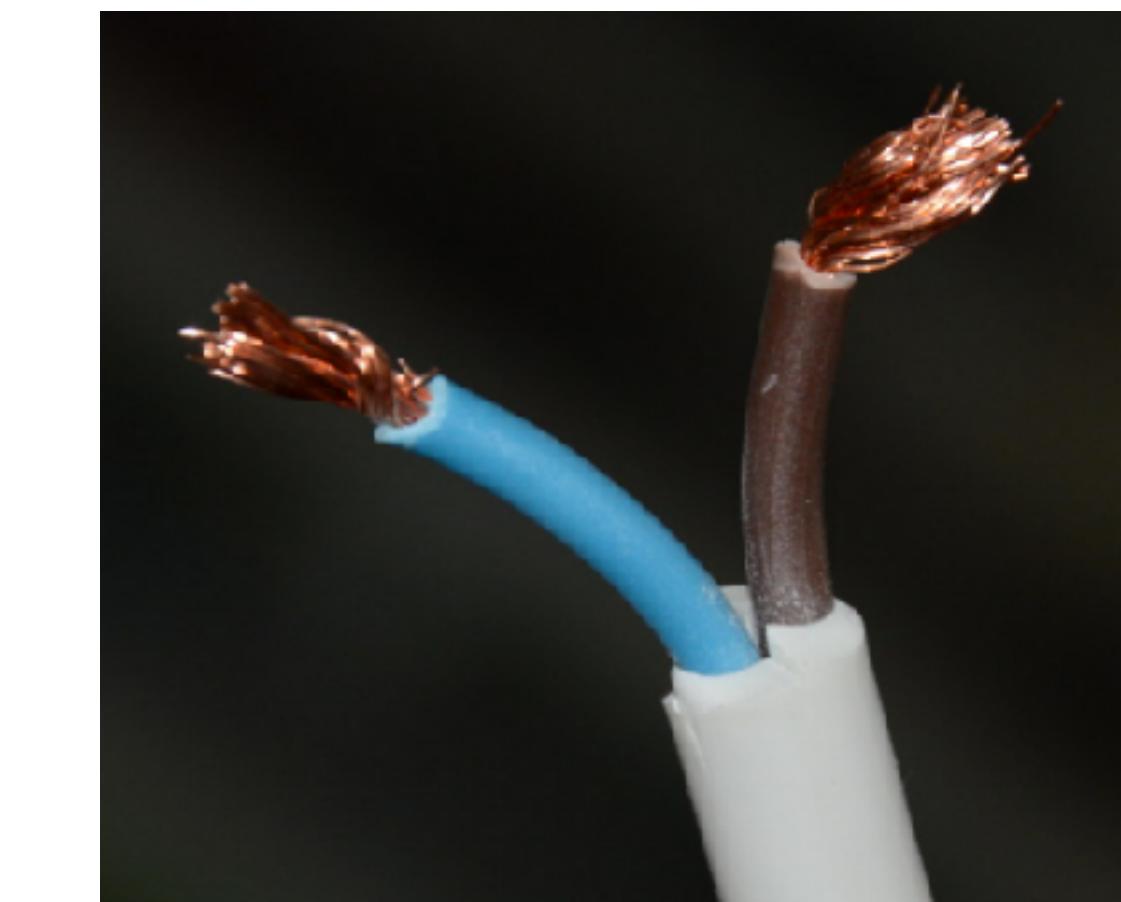
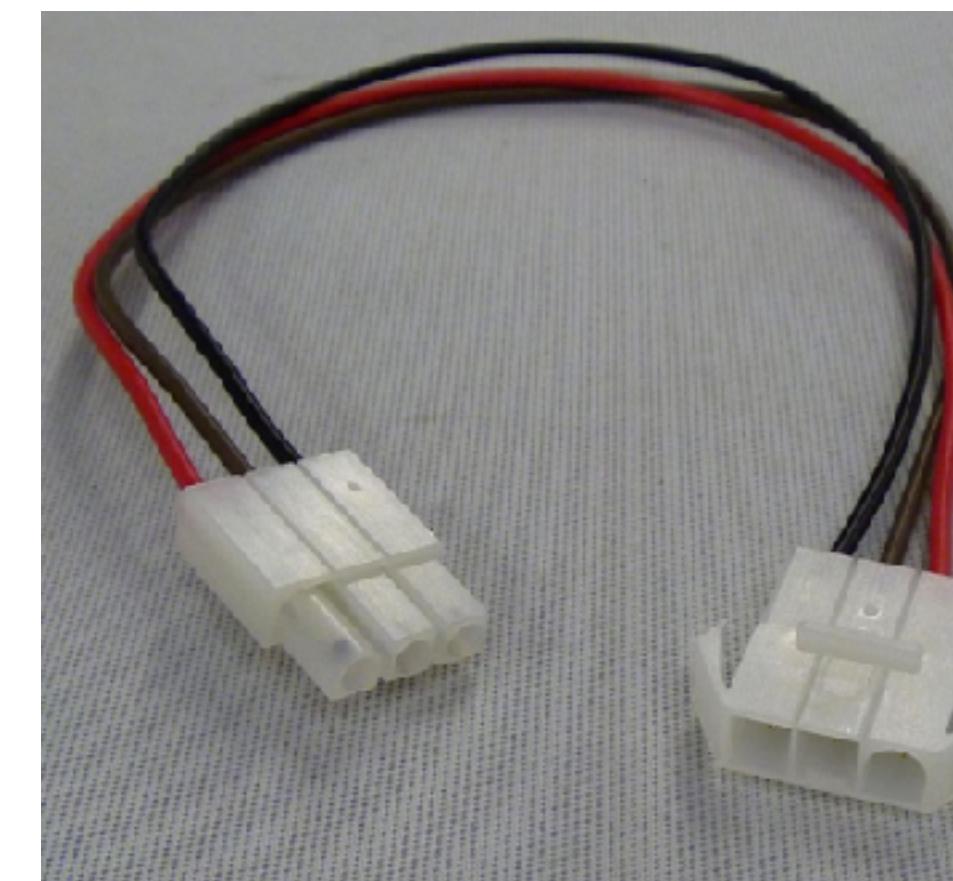
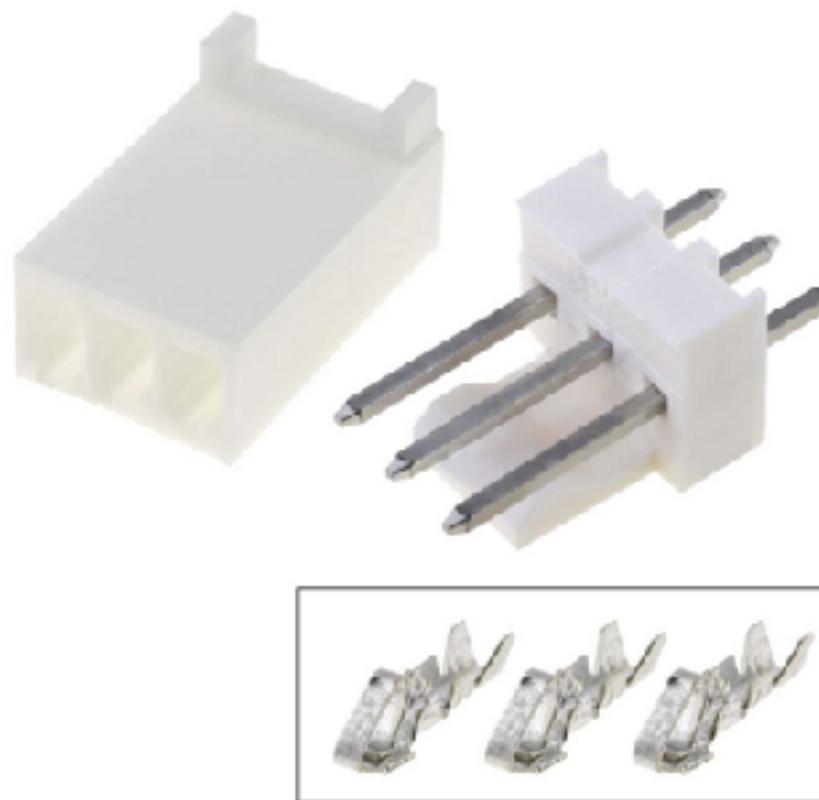
# Prototyping + Testing



# Use connectors & heat shrink!

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- Heat shrink
- Connections - Molex v others
- Working with stranded core wire



# Building an Installation

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## 1. Decide what to do

- Write clearly what function you want performed

## 2. Figure out the environment

- Outside / inside / Power Outlets
- People will / won't touch

## 3. Keep it simple

- Fewer components = less can break
- Consistent wire colors = easier to debug
- Backup circuit = always a good idea

# Exercise in New Design

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**Gesture Writer**

# Exercise in New Design

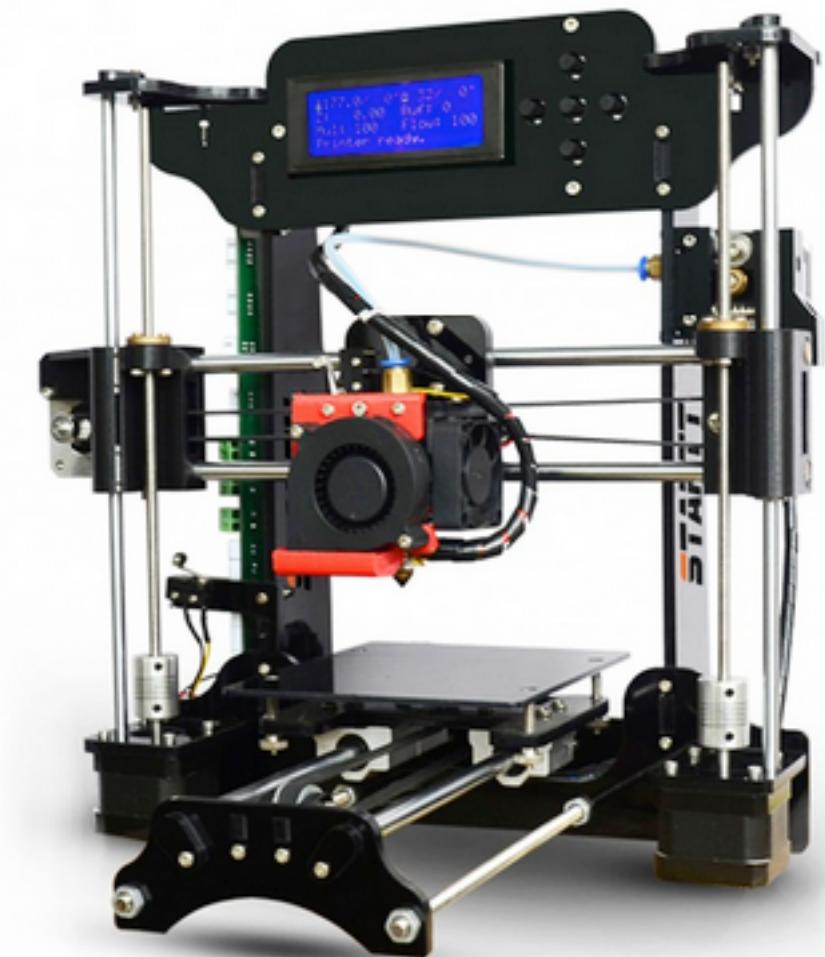
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## Gesture Writer

- Cross Beam arms
- Hanging plotter
- 4 Degree of Freedom arm



[Arduino Plotter](#)



# Other Resources

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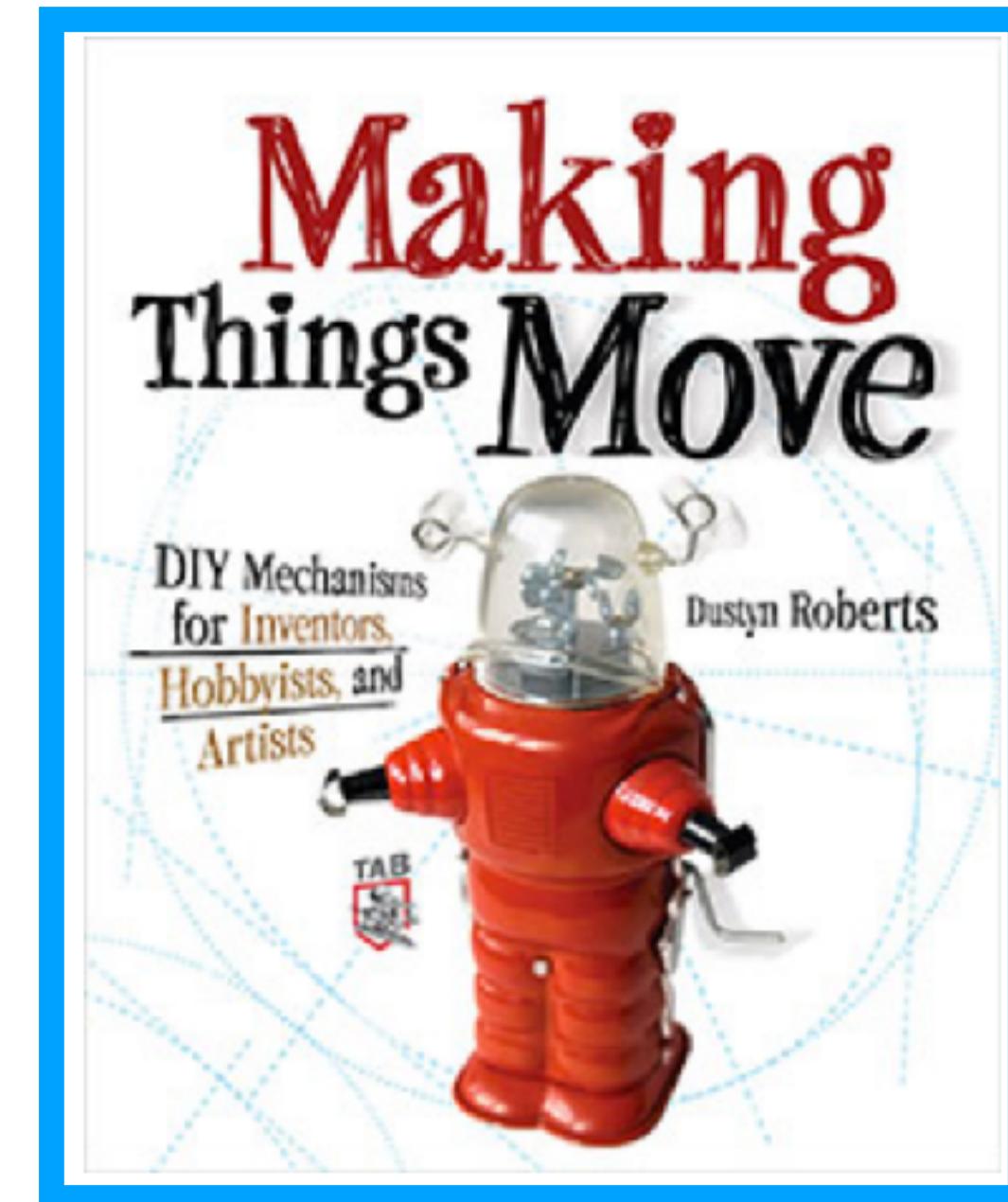
[\*\*Making Things Move\*\*](#) - Dustyn Roberts — good book that dives deeper into all the concepts

Intro to circuits for Artists - “[\*\*Skating the Circuit\*\*](#)” Taeyoon Choi (NYU)

Motor Selection - [\*\*Sparkfun Article\*\*](#) — this website has lots of good tutorials!

[\*\*Using a MOSFET to control a DC motor\*\*](#) - article on [oddwires.com](#) — includes Arduino code

How to Solder - [\*\*Collin's Lab Video\*\*](#) — good video from Adafruit with the basics



# Electronics are a Labor of Love



Thank you! — Jono Sanders