Automated High-Throughput Pipetting Machine

Introduction/Background

High Throughput Screening

- Rapidly Identifies Hits in Large Numbers of Samples
- Takes Advantage of Automated Equipment
- Addresses the Shortcomings of Traditional Drug Discovery

Drug Discovery

- Drug Discovery Entails: Identification, Preclinical Tests, Clinical Trials
- High Costs and Labour-Intensive Process
- Large Quantities of Data Can Be a Bottleneck

One of the shortcomings of HTS in **drug discovery** is the frequent generation of false positives/negatives

Needs Statement

We aim to create an automated multichannel pipetting device for high throughput screening that is accurate for drug discovery usage.

Our Requirements

Max pipetting volume of 100 µL

Minimum pipetting volume of 10µL

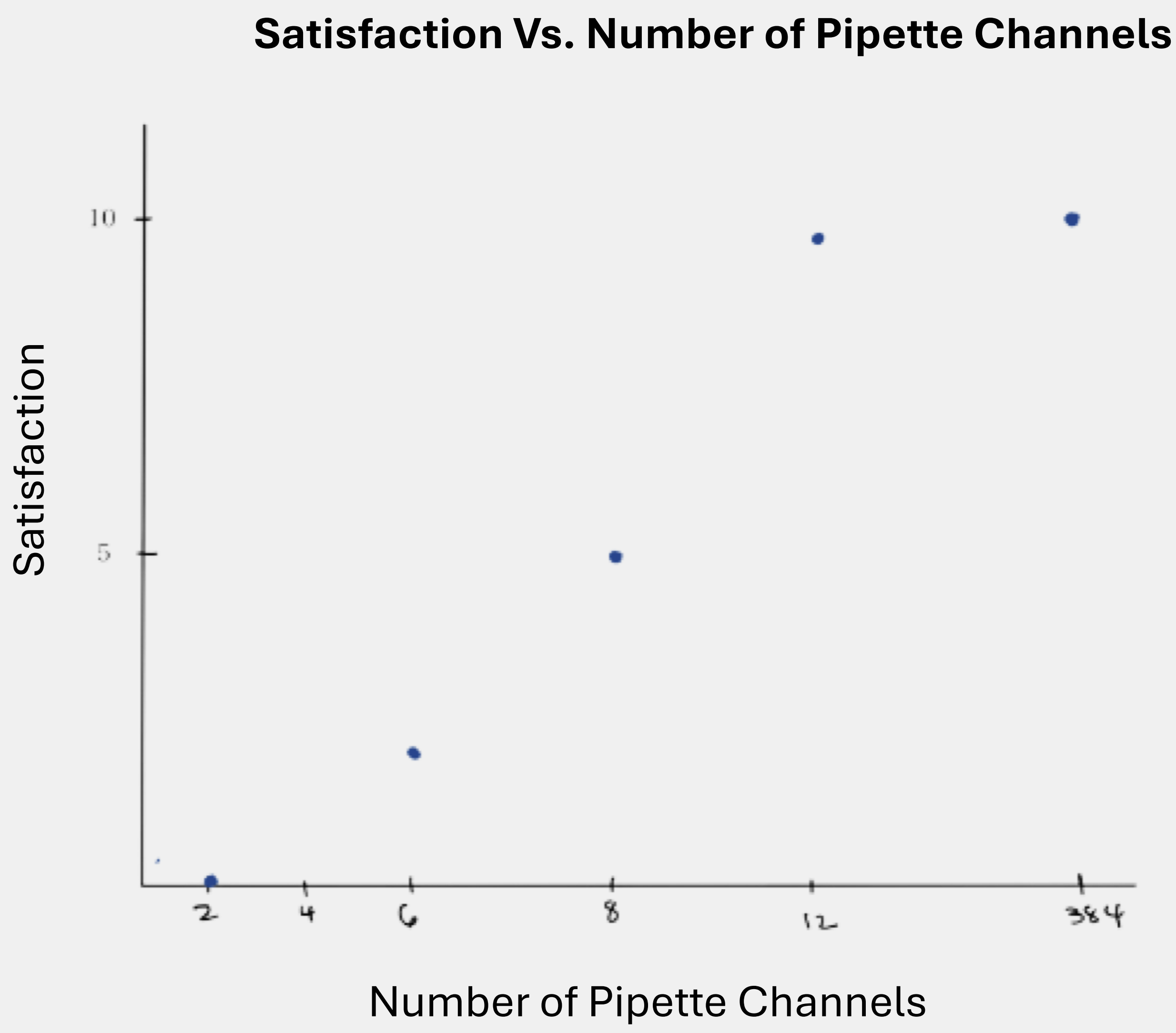
Pipetting speed must be >0.1 µL/s

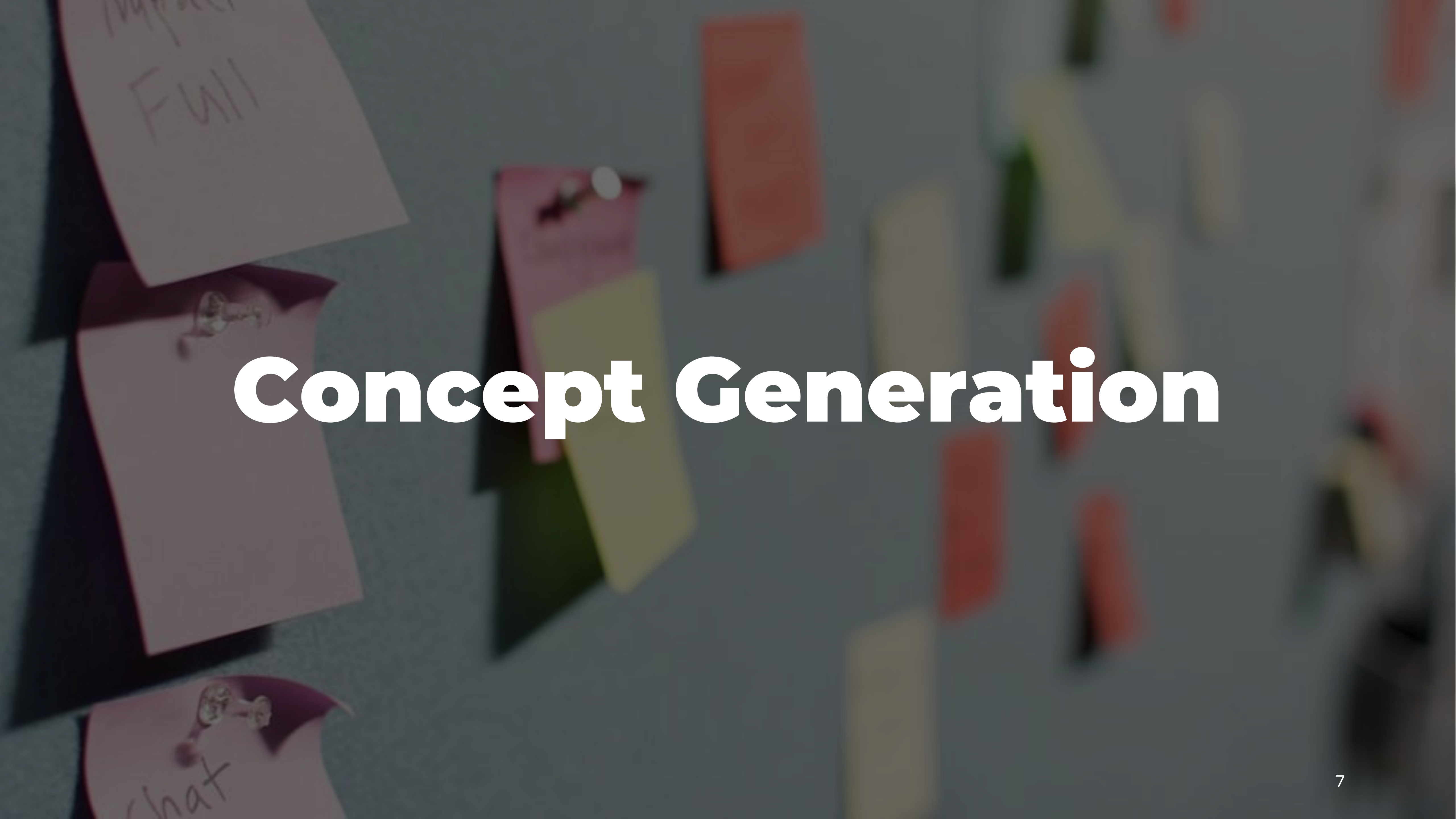
Pipetting speed must be <14 µL/s

Pipette tip distance to bottom of 96 well plate must not exceed 1.35mm

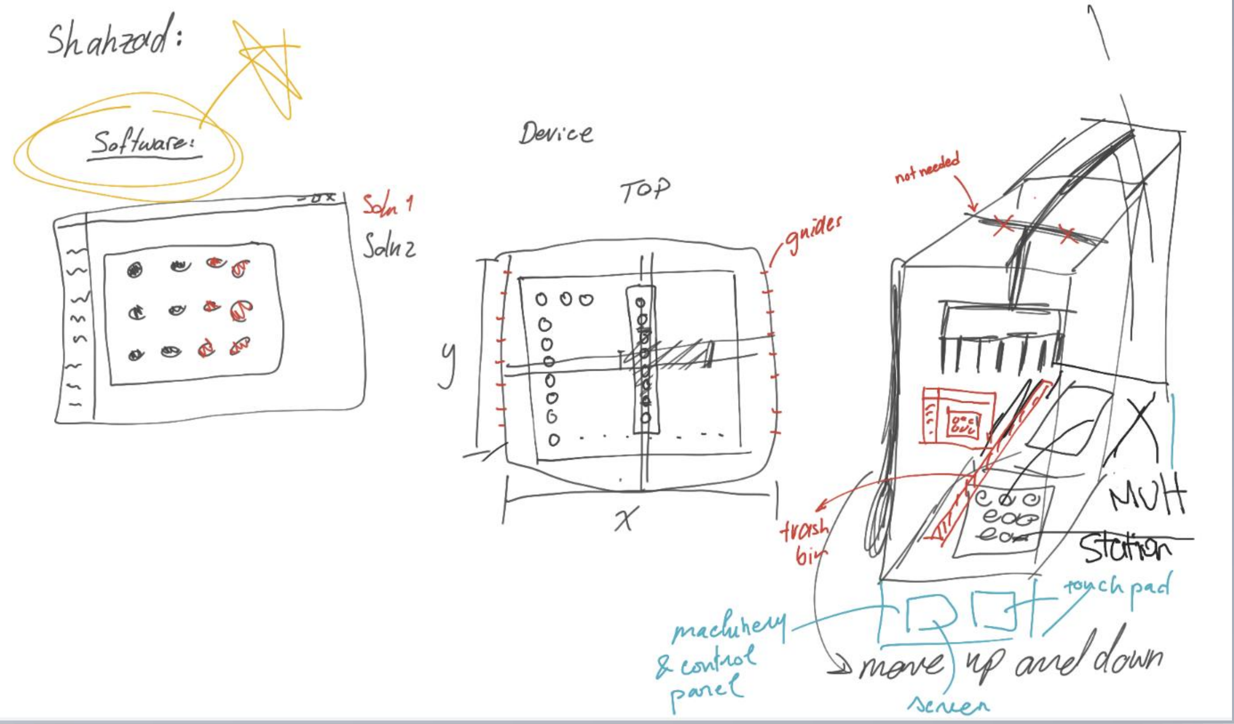
Evaluation Criteria

A greater number of pipetting channels would allow for greater throughput





Concept Generation



Concept #1 – Papa's Pipetteria

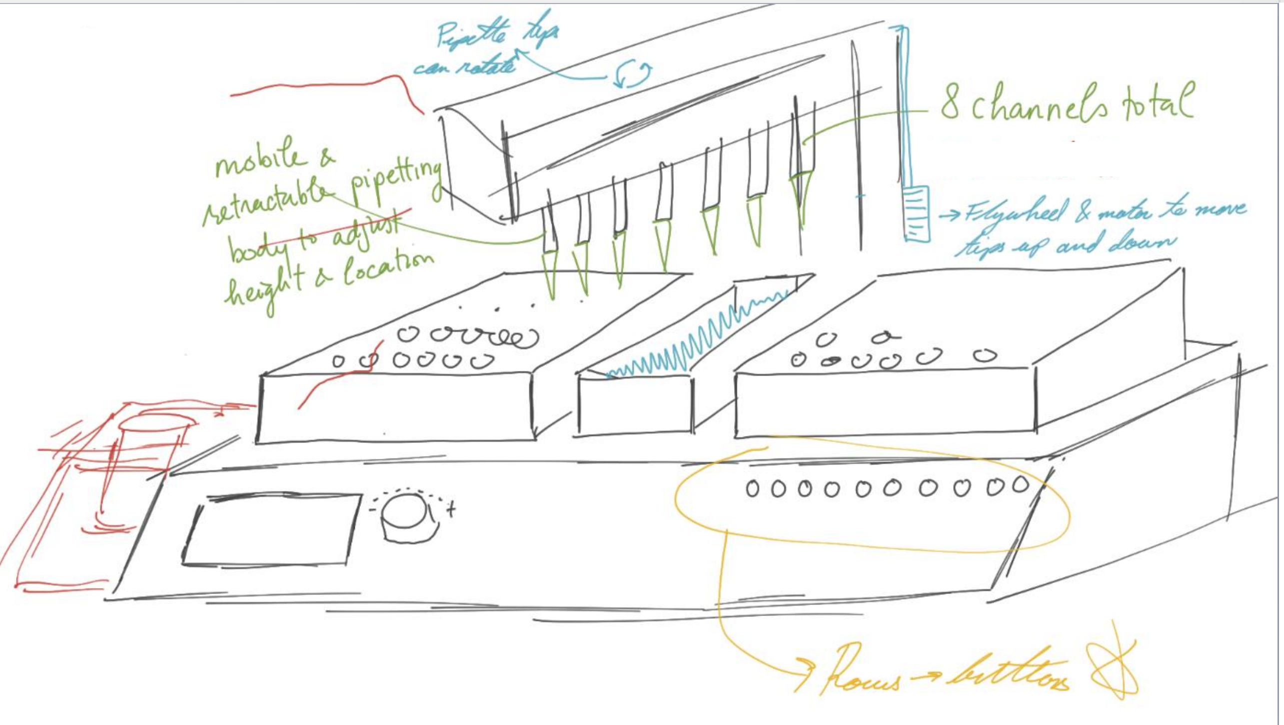
- ✓ Smaller form factor, feasible design
- ✗ Only 4 pipetting channels

Concept #2 – The Regurgitator

- ✓ Large number of pipetting channels
- ✗ Large and heavy, expensive to make commercially

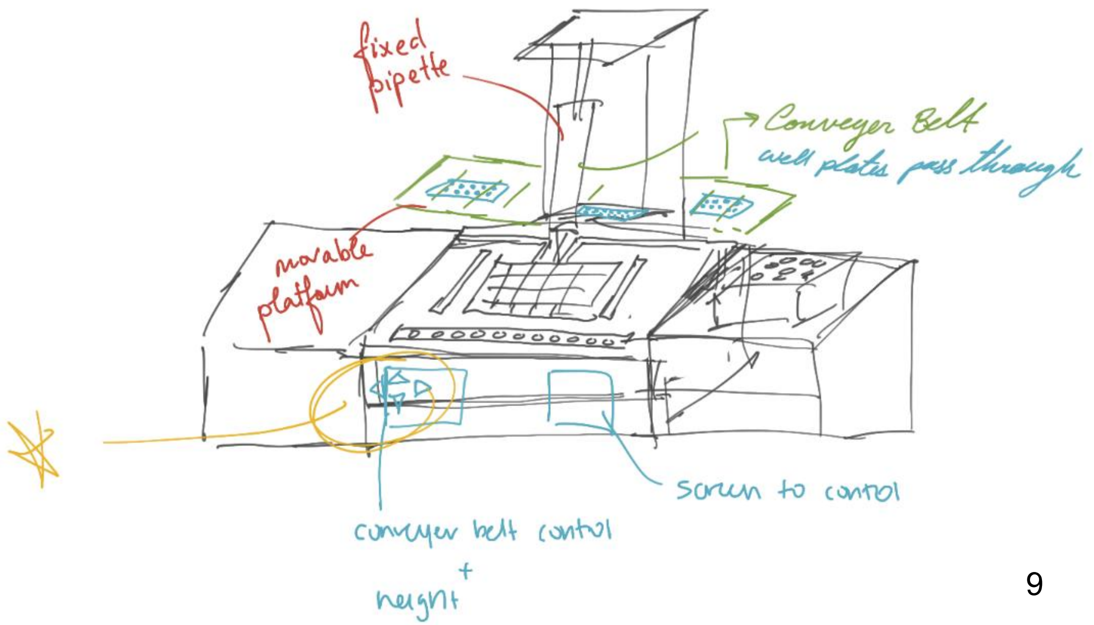
Concept #3 – The Ejectinator

- ✓ **Feasible design, good number of pipetting channels**
- ✗ **Requires a large number of operations from the user**

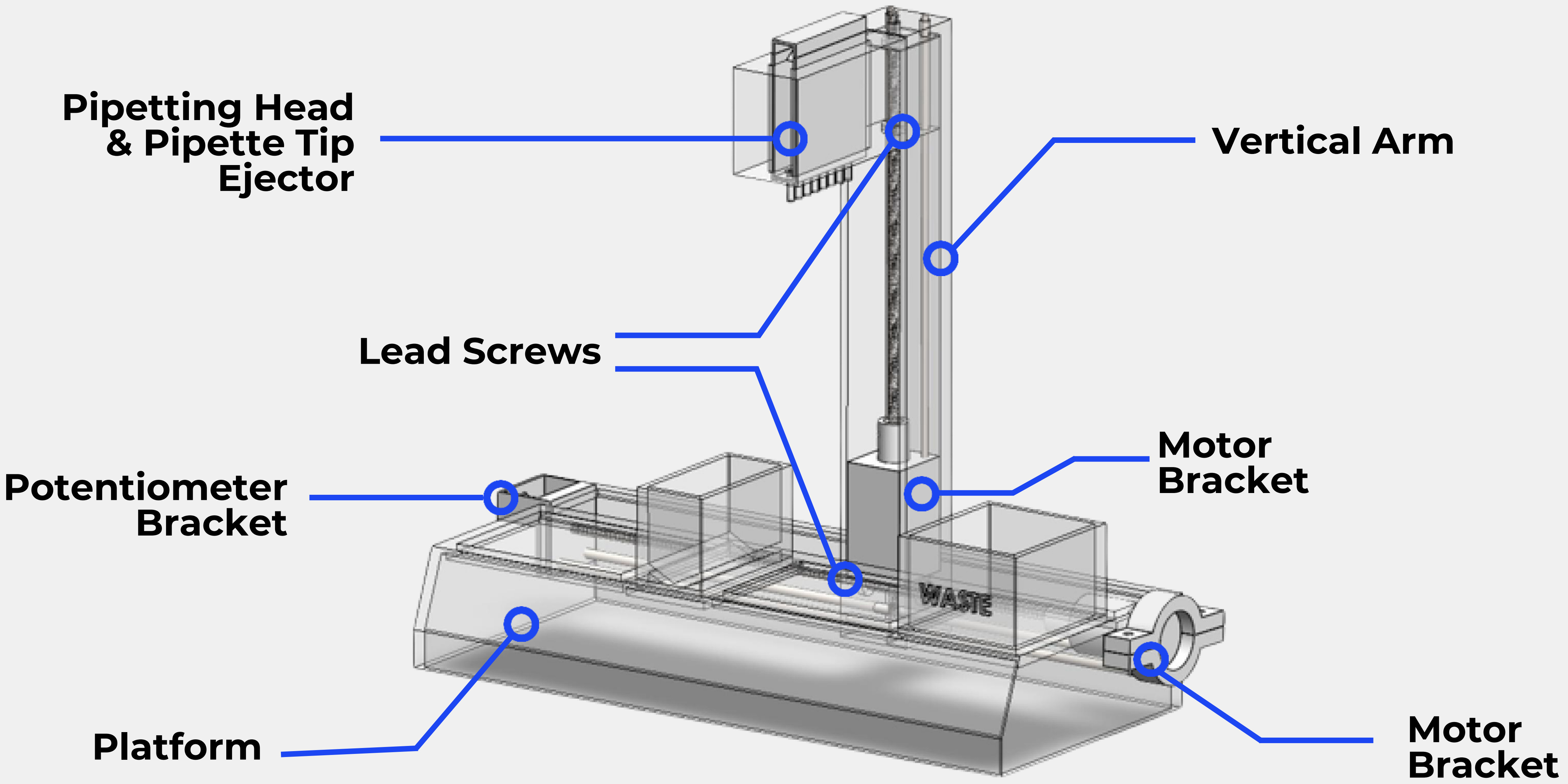


Concept #4 – Radio Box Pipette

- ✓ **Relatively cheaper to construct due to fixed pipette**
- ✗ **Only one pipetting channel**

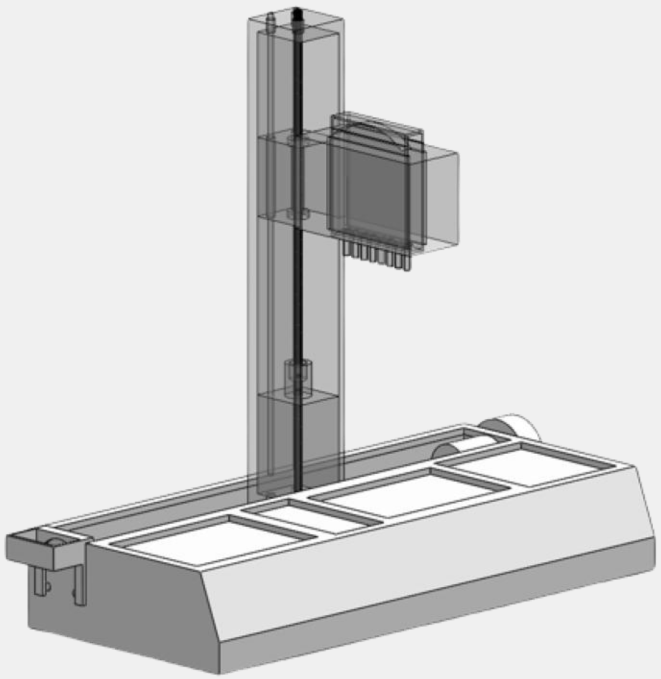


Final Concept

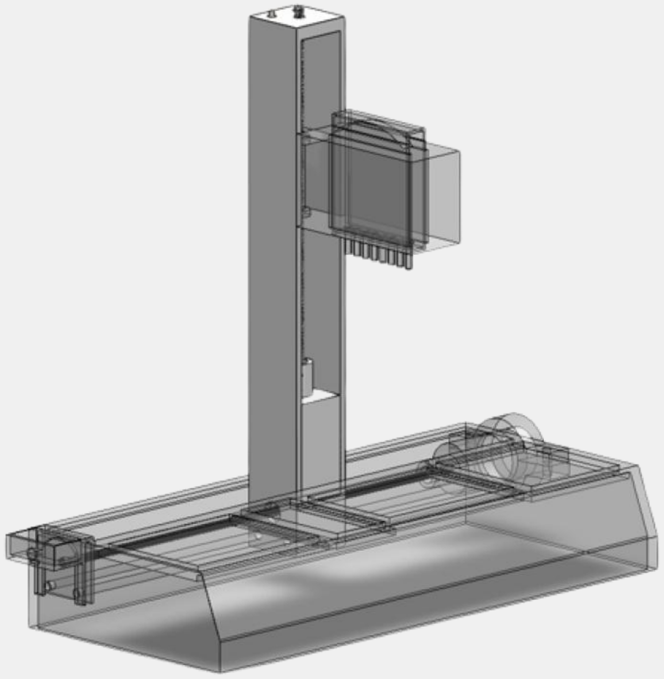


Prototyping

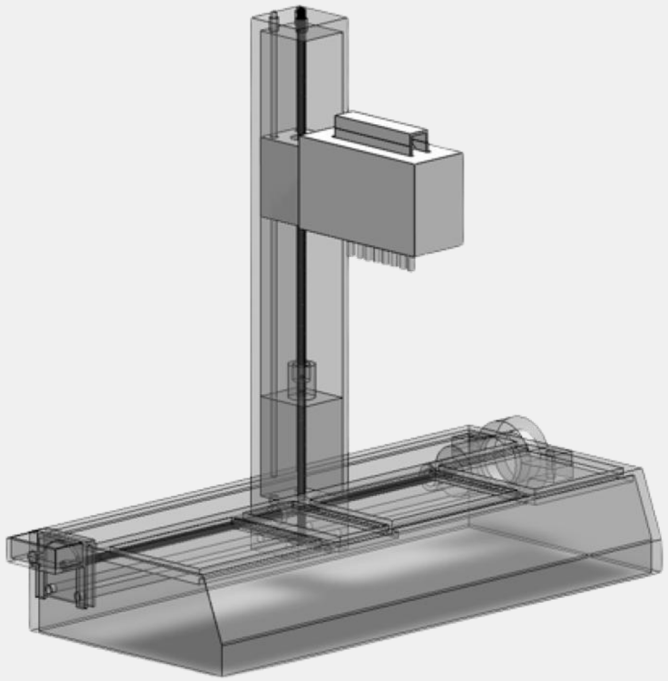
Prototype Details



Main Device Platform/Body

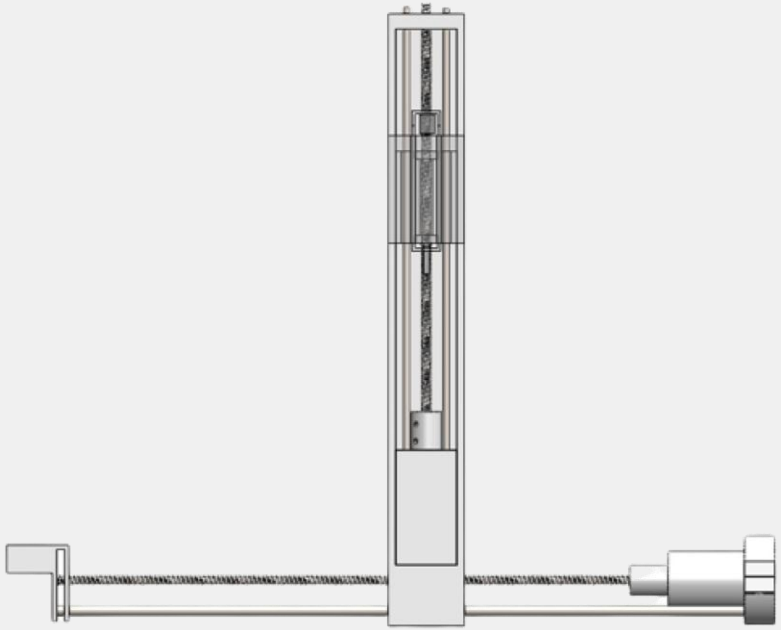


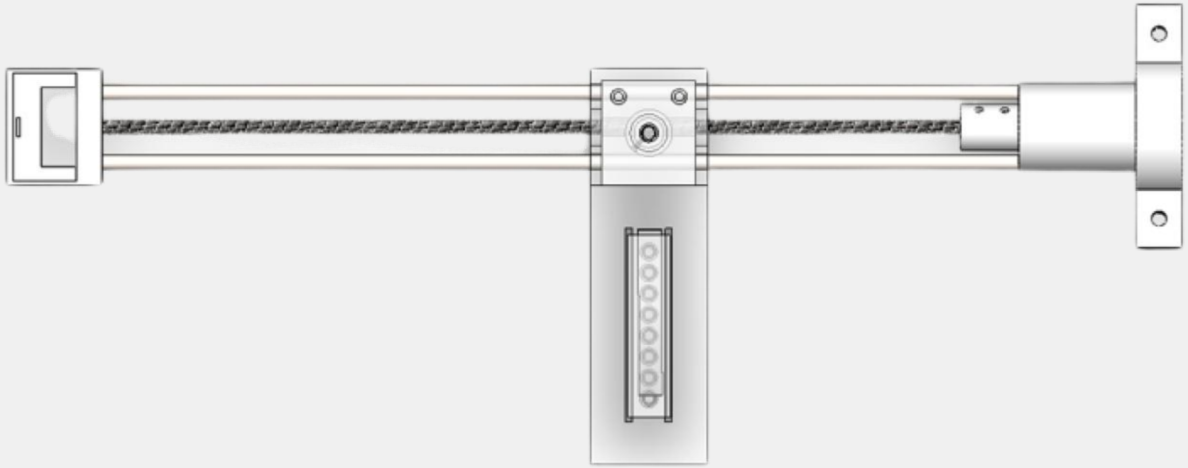
Device Vertical Arm

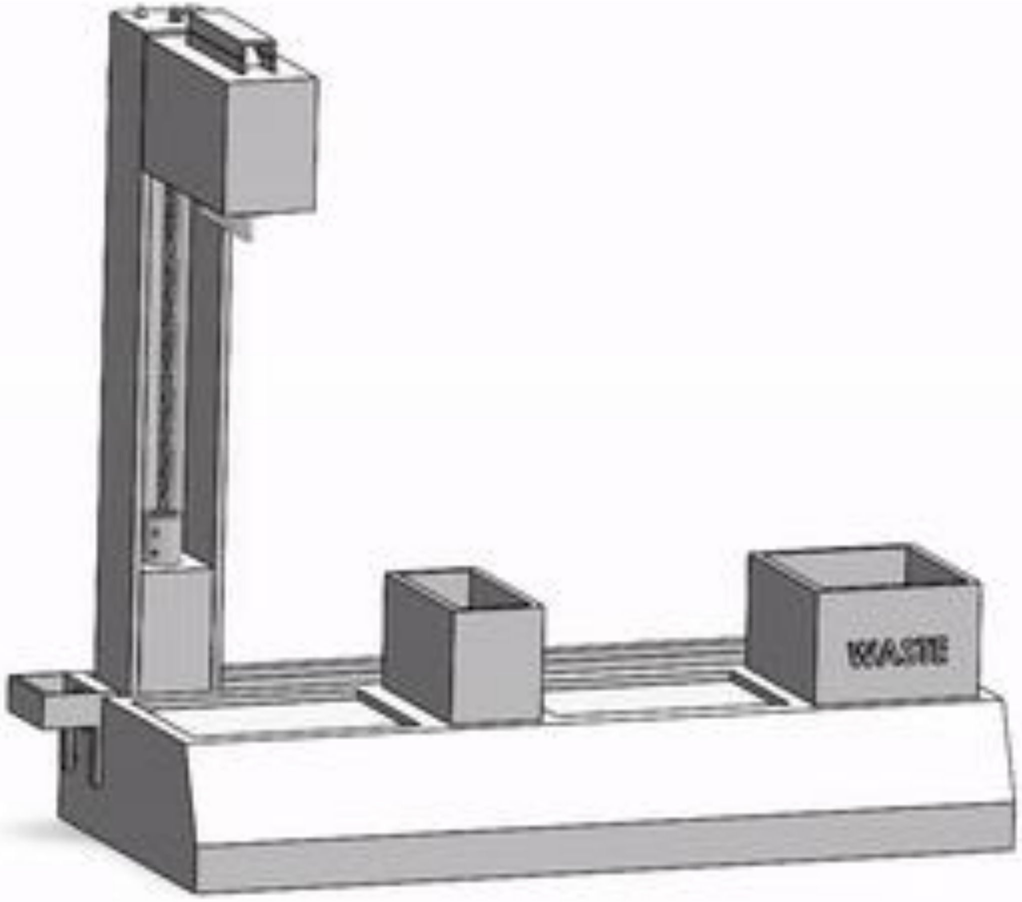


Device Horizontal Arm

Prototype **Motion**

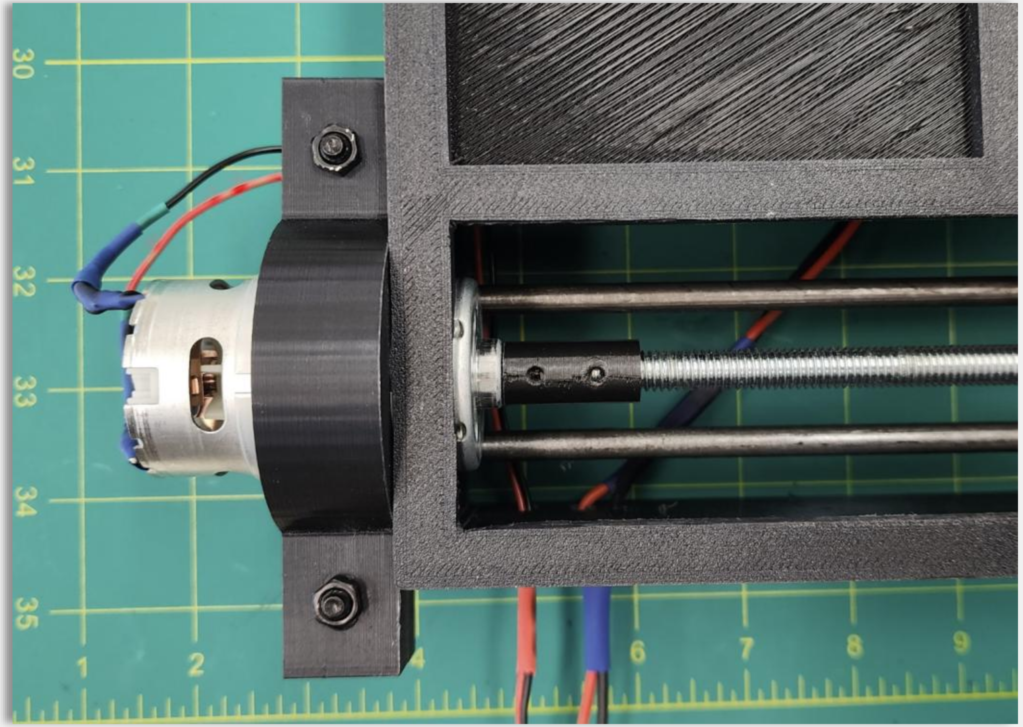


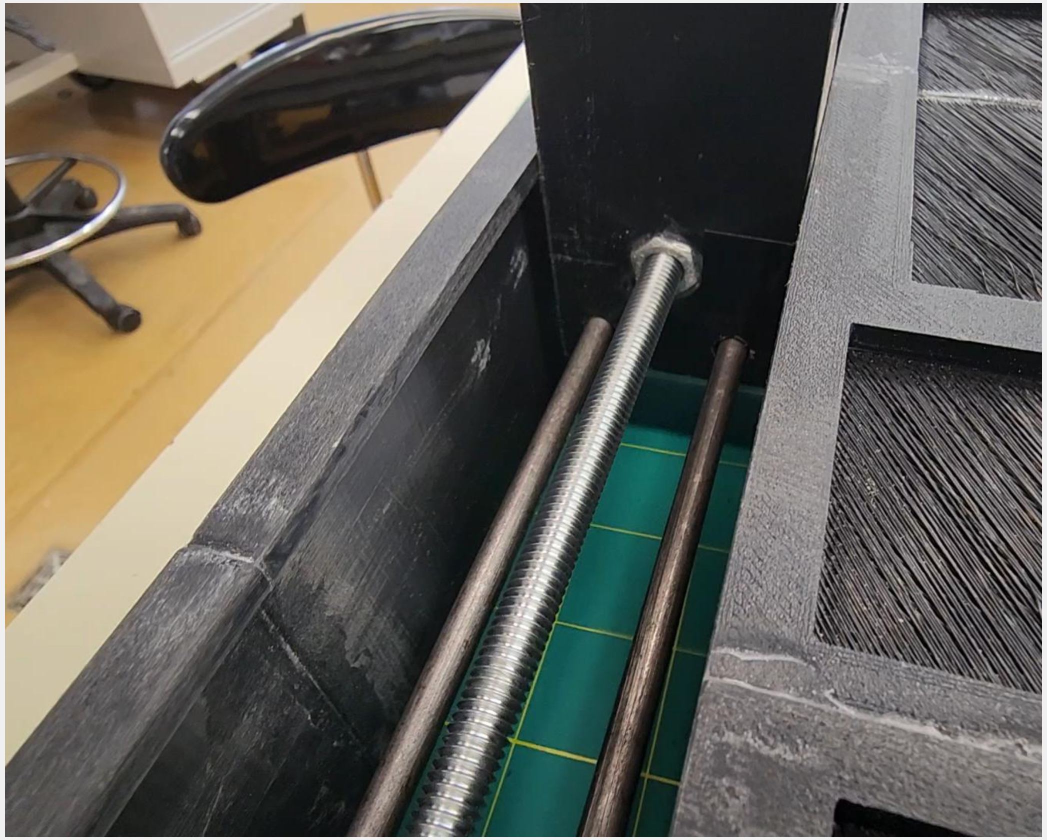




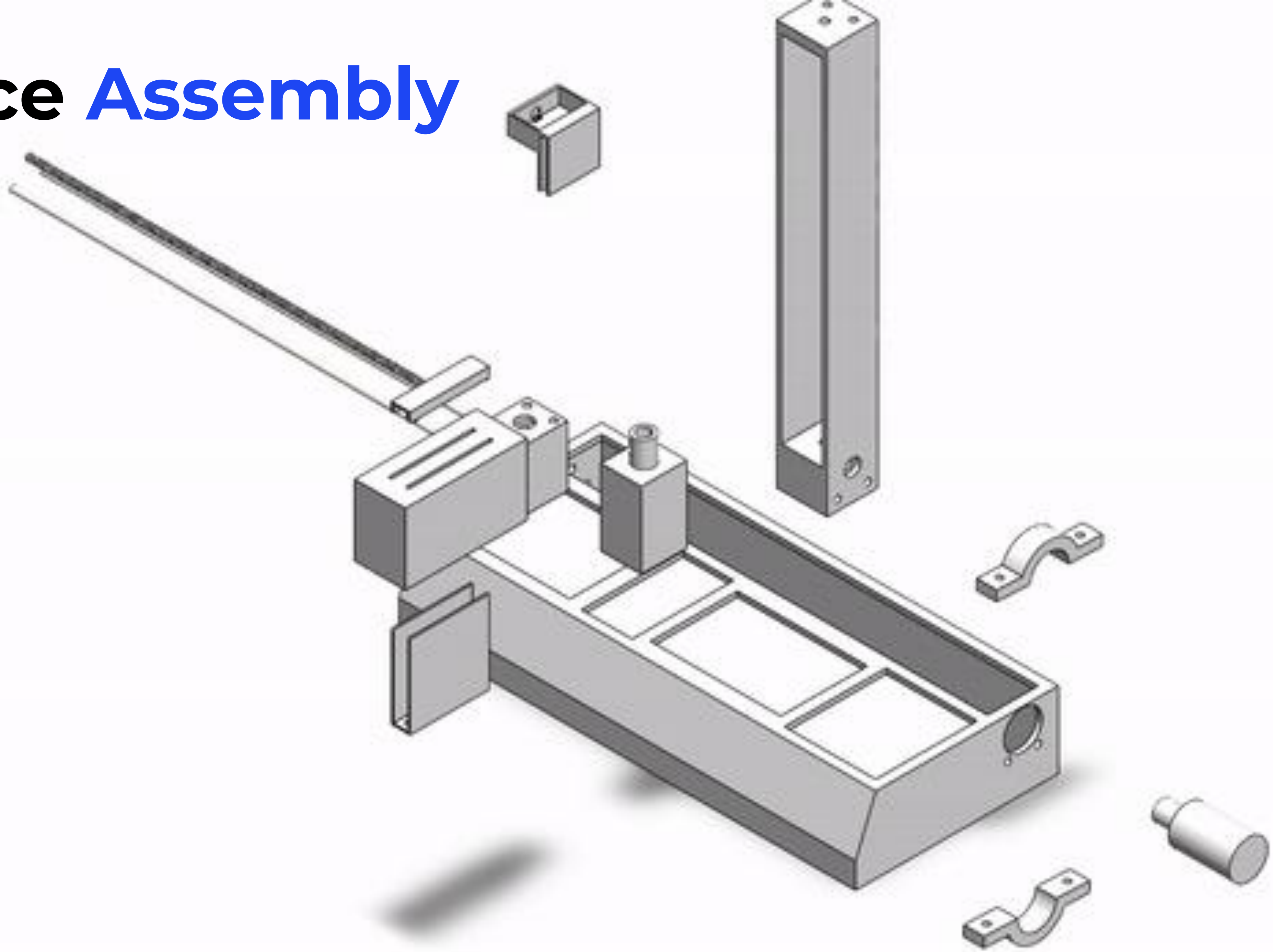
How it Works

Linear motion is achieved using lead screws made with a ¼ inch threaded rod that pushes and pulls the vertical arm as the rod rotates

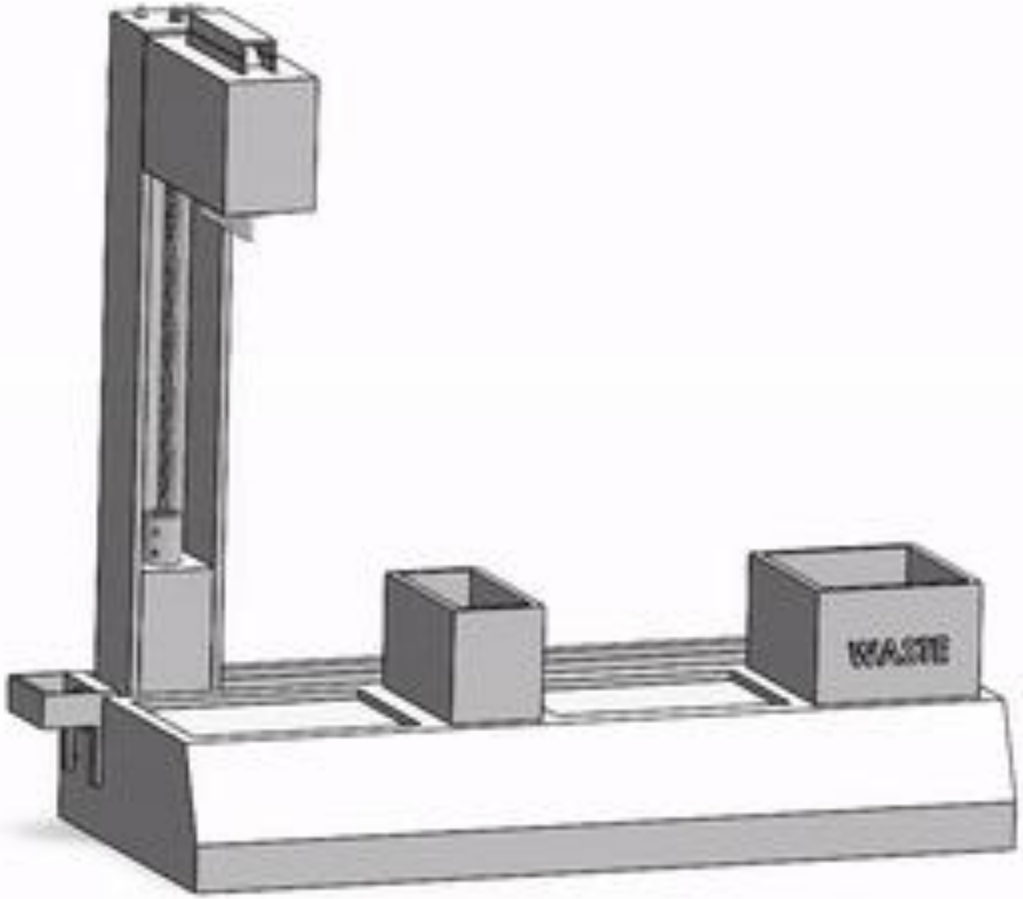




Device Assembly



Testing


WASTE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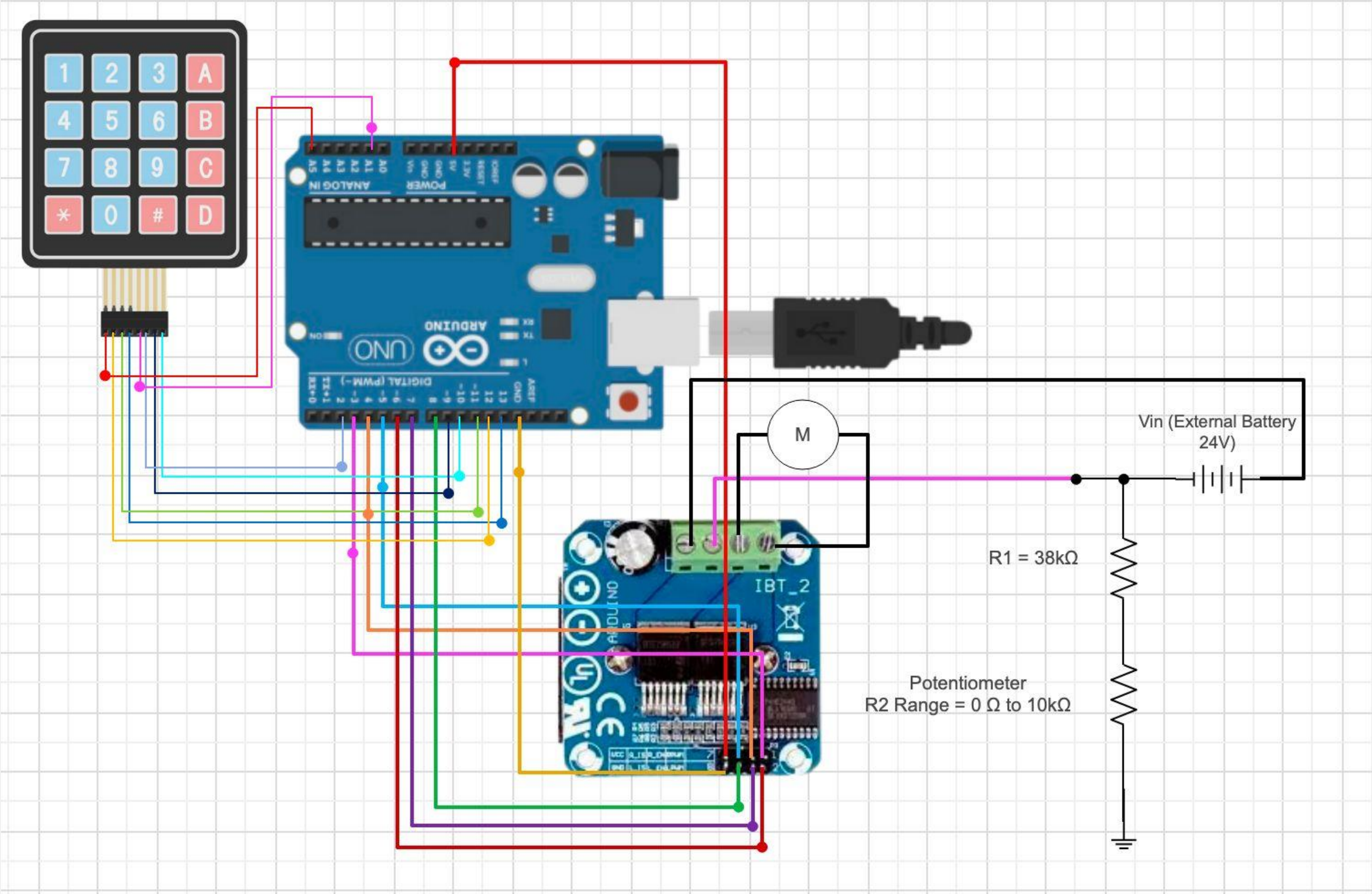
Circuitry/Programming

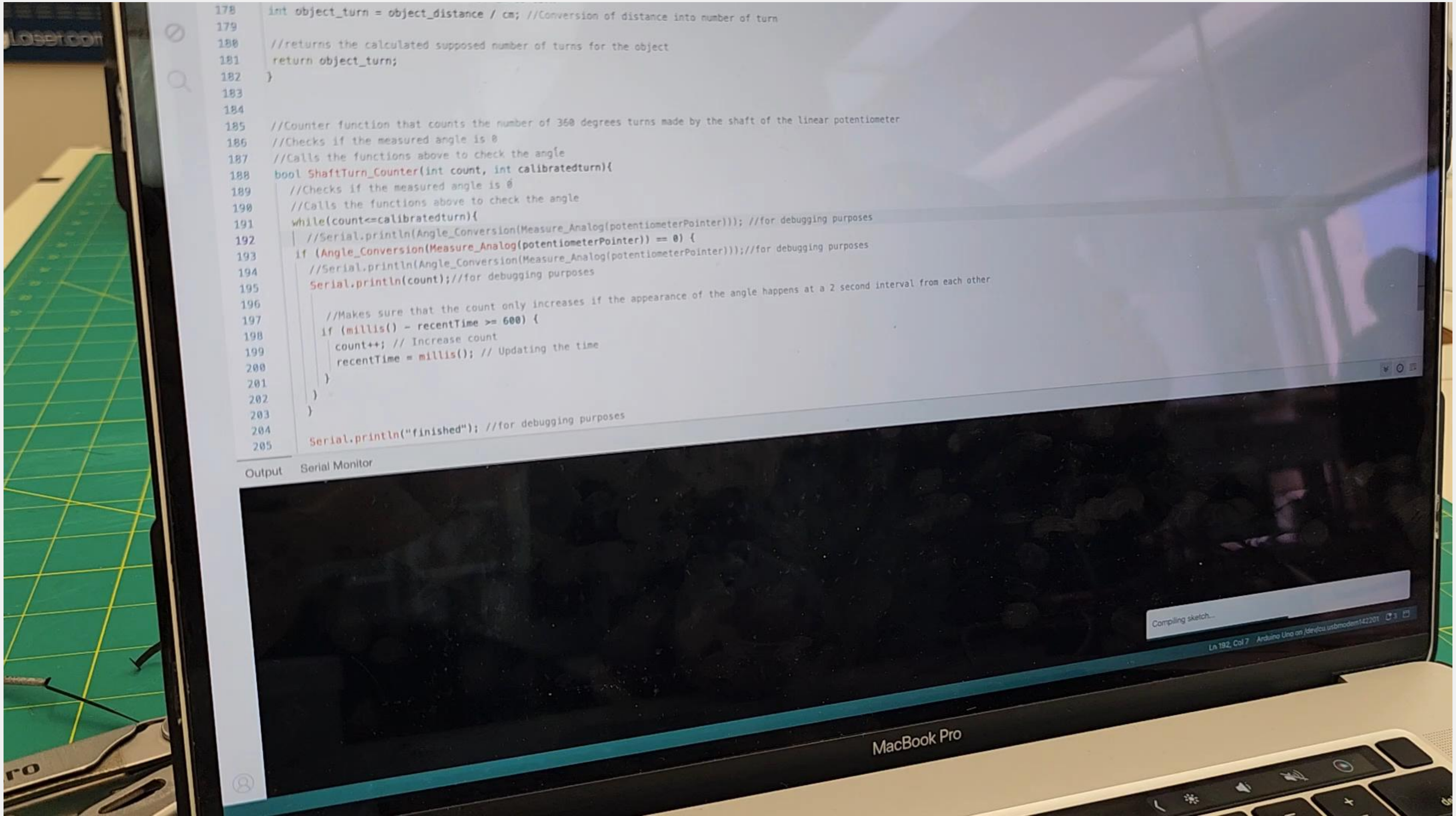
Circuit Design

- **Main components**: DC motors and BTS7690 motor drivers, Keypad, Arduino UNO, Voltage divider, Rotary Potentiometer
- **Sensing circuit** used to obtain horizontal positional information of the vertical arm
- Voltage divider Vs. Wheatstone Bridge

*Circuit diagram for horizontal movement of vertical arm



Programming



***Motor is running from when the keypad is pressed up until it falls out of the hand**

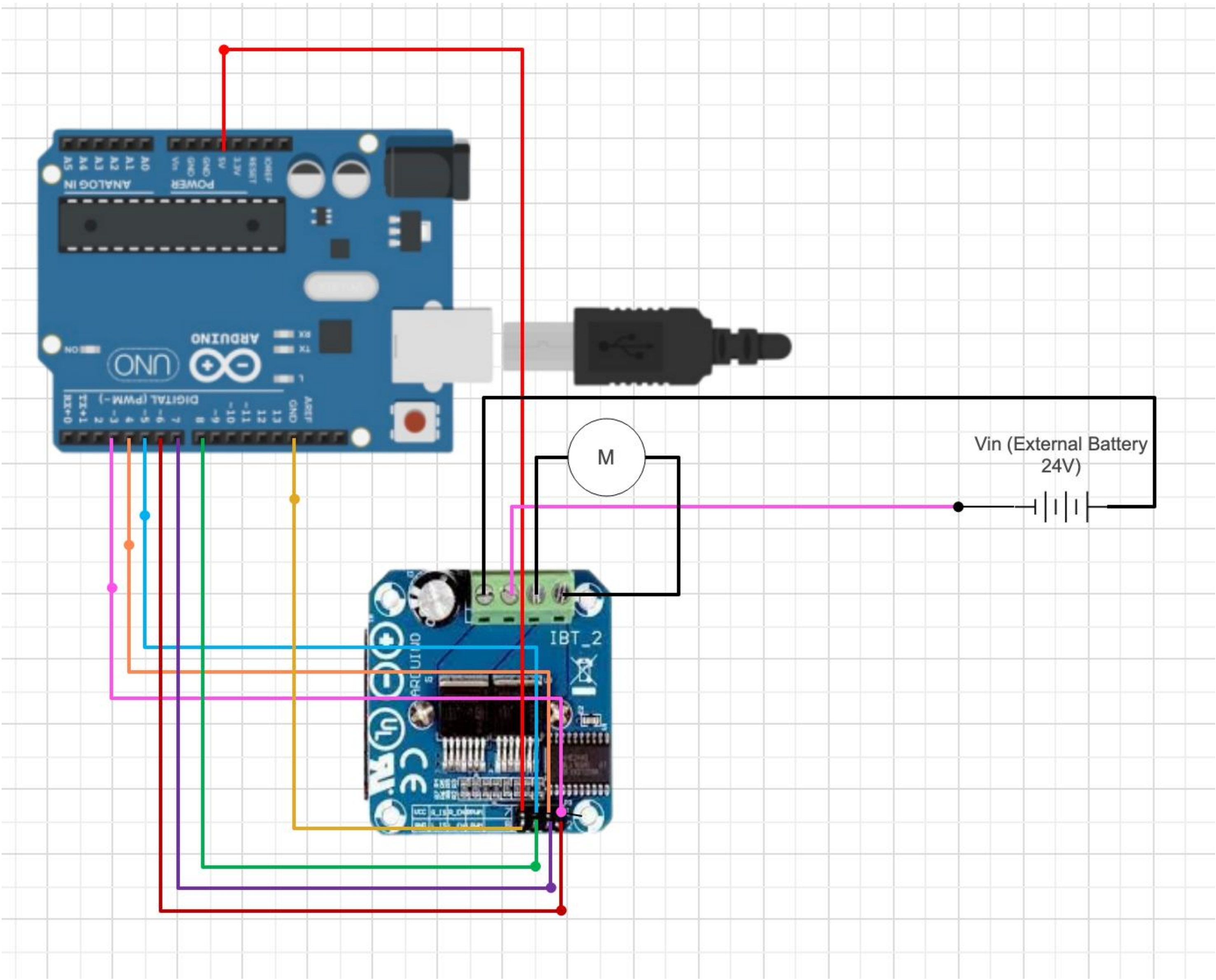
Summary

Needs Statement
Create an automated multichannel pipette that is accurate enough for use in drug discovery

Main Requirements
Main requirements focused on pipetting volume and pipetting speed, placing an emphasis on accuracy

Mechanical Design
Uses a system of lead screws to move the pipetting head in an X and Y coordinate system

Circuit and Programming
Sensing circuit uses a potentiometer to sense position of pipetting head and works together with a system of motors to power the device


M
Vin (External Battery
24V)
IBT_2

Weighted decision matrix													
Evaluation Criteria	Weight	Radiobox		The Ejectinator		Papa's Pipetteria		The Regurgitator		Clip On Rotary		Final Concept	
		raw	weighted	raw	weighted	raw	weighted	raw	weighted	raw	weighted	raw	weighted
Number of Pipetting Channels	0.25	5	1.25	5	1.25	1	0.25	9	2.25	5	1.25	5	1.25
Number of Operations	0.2	0	0	2	0.4	4	0.8	2	0.4	4	0.8	3	0.6
Cost	0.25	6	1.5	8	2	0	0	0	0	7	1.75	8.5	2.125
Speed of Aspiration	0.15	4.5	0.675	4.5	0.675	7	1.05	2.3	0.345	4.5	0.675	4.5	0.675
Weight	0.15	6	0.9	8	1.2	0	0	0	0	4	0.6	9	1.35
TOTAL Weighted SCORES	1		4.325		5.525		2.1		2.995		5.075		6