

# Electroplating 3D Printer Design Day

## GNG5140

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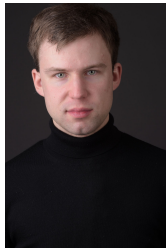
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Team:

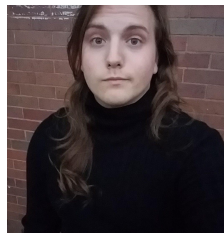
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Jacob Jurkovich



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# Overview

- Background
- Problem Statement
  - Customer Requirements
- Design Requirements
  - Scope
    - How it changed
- UN Sustainability
- Prototyping
- Final Design

# Background & Problem Statement

- This project comes from ECRIT, an initiative started in Vietnam by Dr. David Bruce who was studying hyper hydrophilic surfaces.

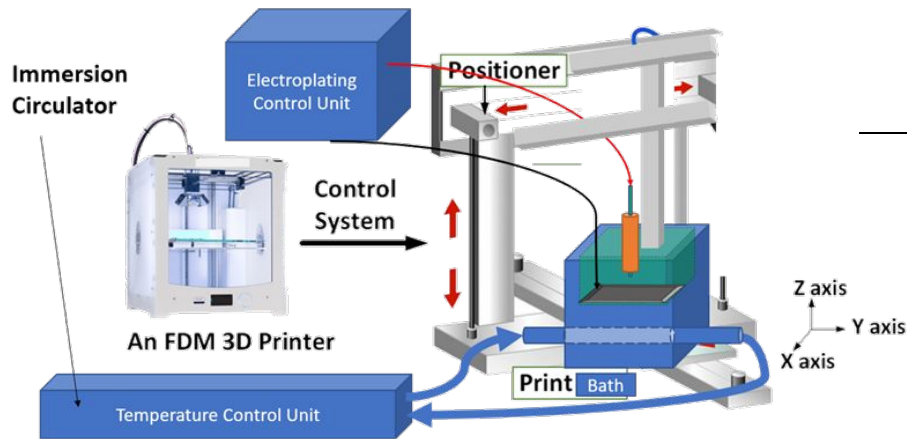


Figure 2: Customer Concept

## Problem Statement:

To develop a 3D electroplating prototype that gives control over the plating area.

# Requirements - Customer

Label	Customer Requirement	Priority
C1	Nickel Plating Capability	5
C2	Precise Movements	5
C3	Hydrogen Bubble Templating (HBT)	5
C4	Easy to maintain	4
C5	Open Source	3
C6	Easy to make/maintain	3
C7	Environmentally Friendly	2
C8	Swappable Components	1

# Requirements - Design

Design Requirements	Relation	System	Rating
Utilize Existing 3D Printer	C2 C5 C4 C6	Movement	5
Accurate Current ( $2A/cm^2$ )	C1 C3	Plating	5
Contained solution	C6 C7	Pump	5
Precise plating current	C1 C3	Plating	4
Print Speed (X,Y)	C1 C2	Movement	4
Z- Precision	C1 C2	Movement	3
Thin anode and Feed stock precision	C1 C2 C3	Feeder	3
Bed temperature difference	C1 C3	Heating	3
Configurable voltage/current	C5 C8	Plating	2
Feed rate	C1 C4 C7 C8	Feeder	1
Pumping (Fluid out, clean solution, drain)	C4 C6	Pump	1
Bed temperature variance	C1 C3	heating	1

# UN Sustainability



# Prototype Phase 1

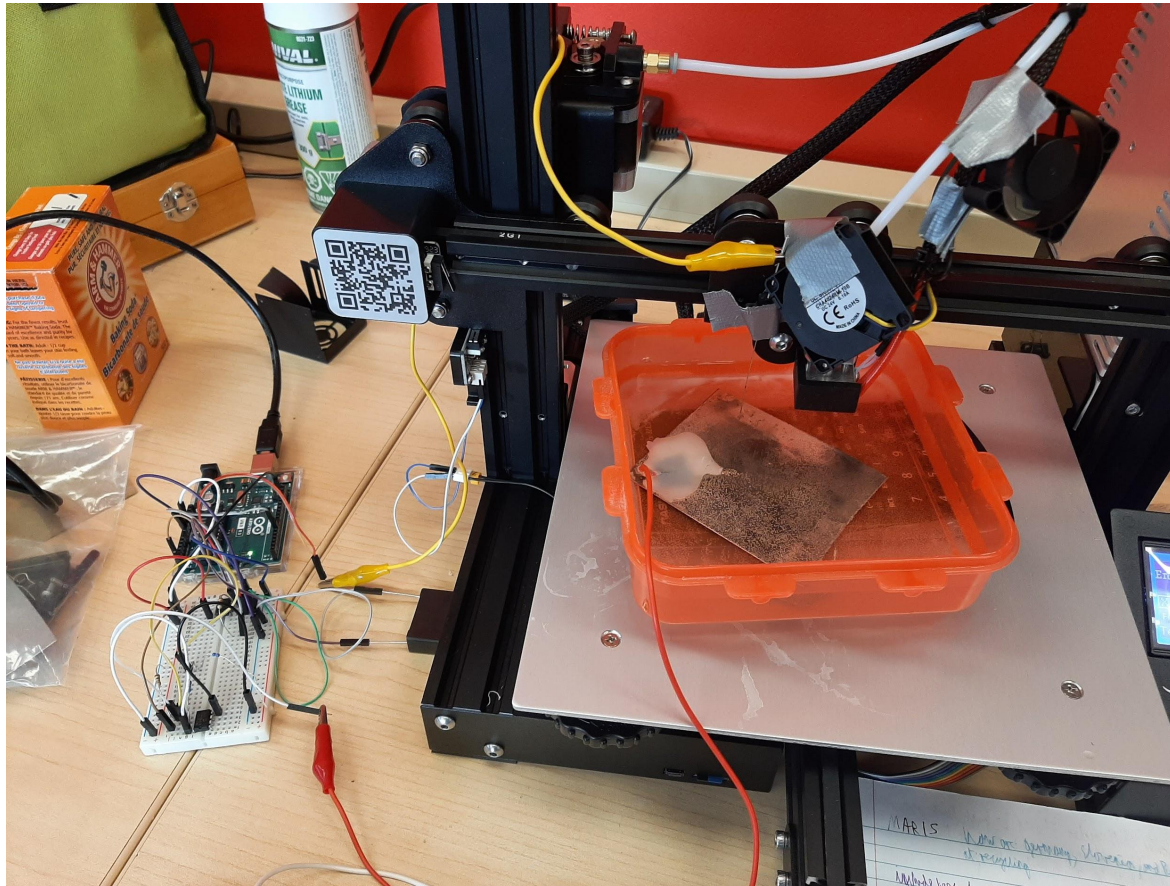


Figure 3: Electroplating printer Prototype #1



# Prototype Phase 2

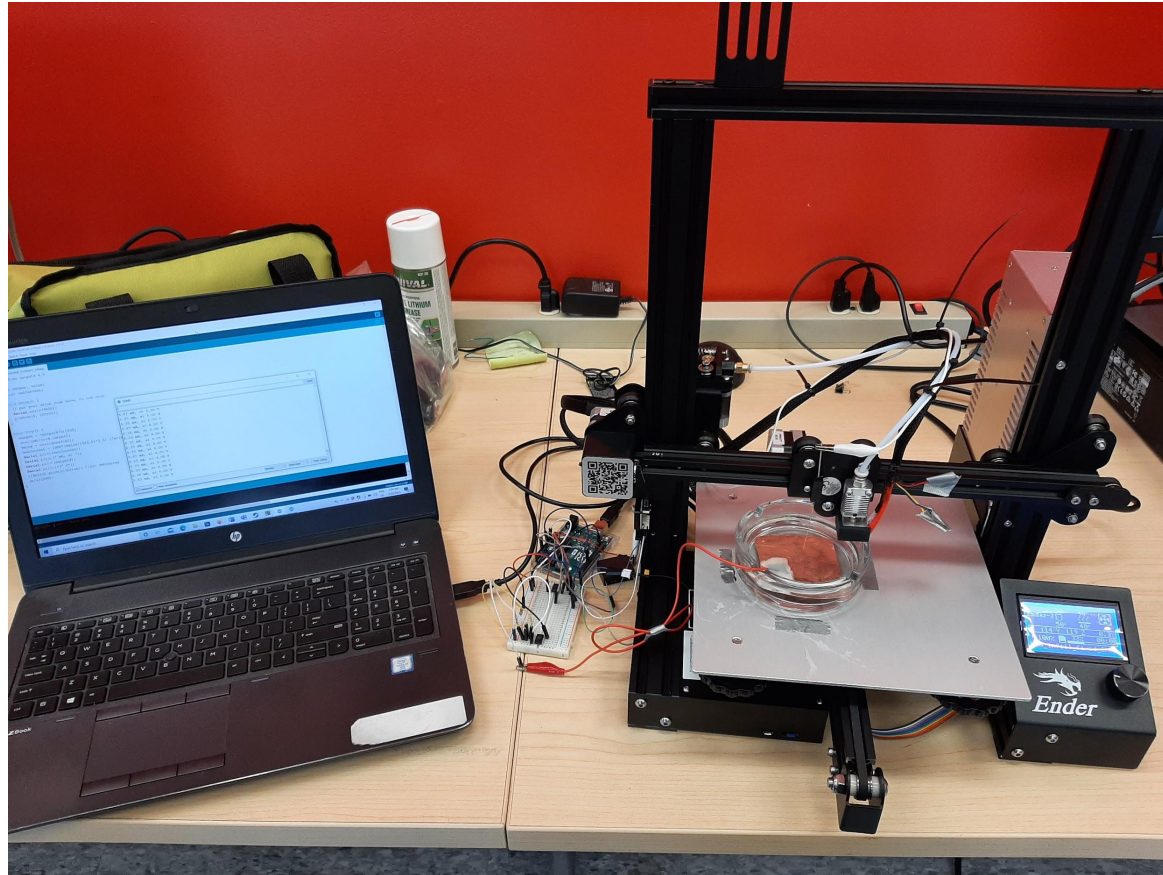
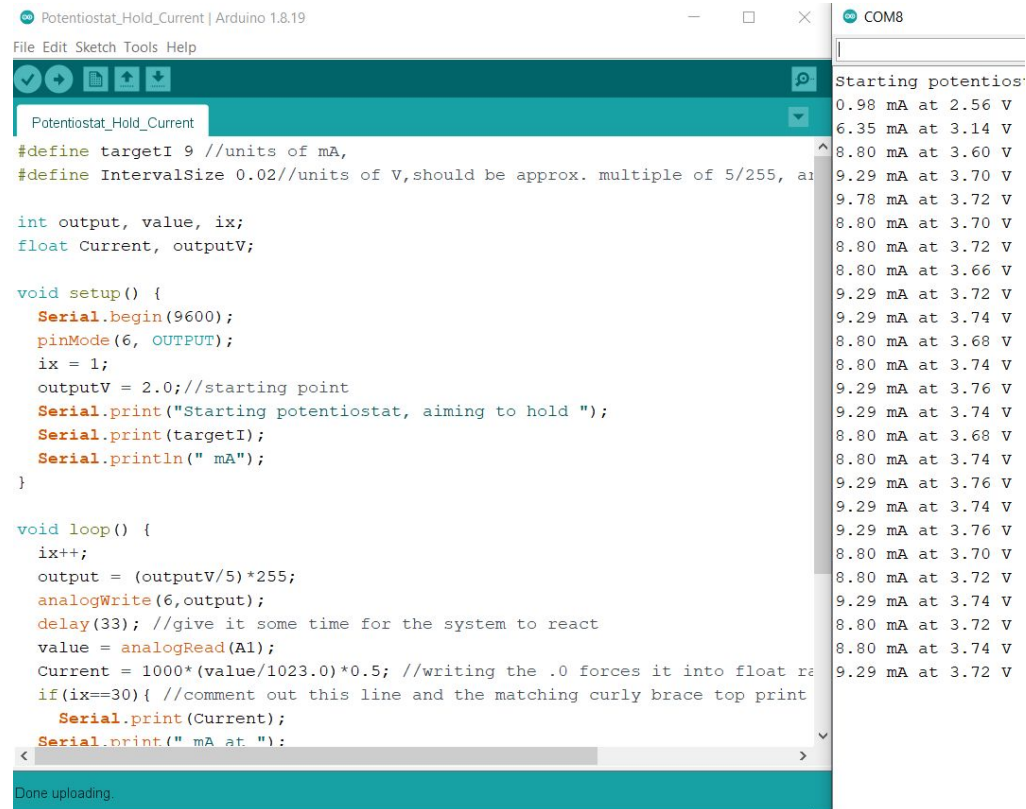


Figure 4: Electroplating Printer Final Prototype



# Prototype Phase 2



The screenshot shows the Arduino IDE interface. The main window displays the sketch 'Potentiostat\_Hold\_Current' for an Arduino 1.8.19. The code defines a target current of 9 mA and an interval size of 0.02 V. It sets up a serial connection at 9600 baud and configures pin 6 as an output. The setup function initializes the output voltage to 2.0V and prints the starting potentiostat value. The loop function increments the output voltage by 0.02V every 33ms and prints the current value every 30 iterations.

```

#define targetI 9 //units of mA,
#define IntervalSize 0.02//units of V,should be approx. multiple of 5/255, and

int output, value, ix;
float Current, outputV;

void setup() {
  Serial.begin(9600);
  pinMode(6, OUTPUT);
  ix = 1;
  outputV = 2.0;//starting point
  Serial.print("Starting potentiostat, aiming to hold ");
  Serial.print(targetI);
  Serial.println(" mA");
}

void loop() {
  ix++;
  output = (outputV/5)*255;
  analogWrite(6,output);
  delay(33); //give it some time for the system to react
  value = analogRead(A1);
  Current = 1000*(value/1023.0)*0.5; //writing the .0 forces it into float range
  if(ix==30){ //comment out this line and the matching curly brace top print
    Serial.print(Current);
    Serial.print(" mA at. ");
  }
}

```

The serial monitor (COM8) shows the output of the sketch, displaying the starting potentiostat value and the current value every 30 iterations.

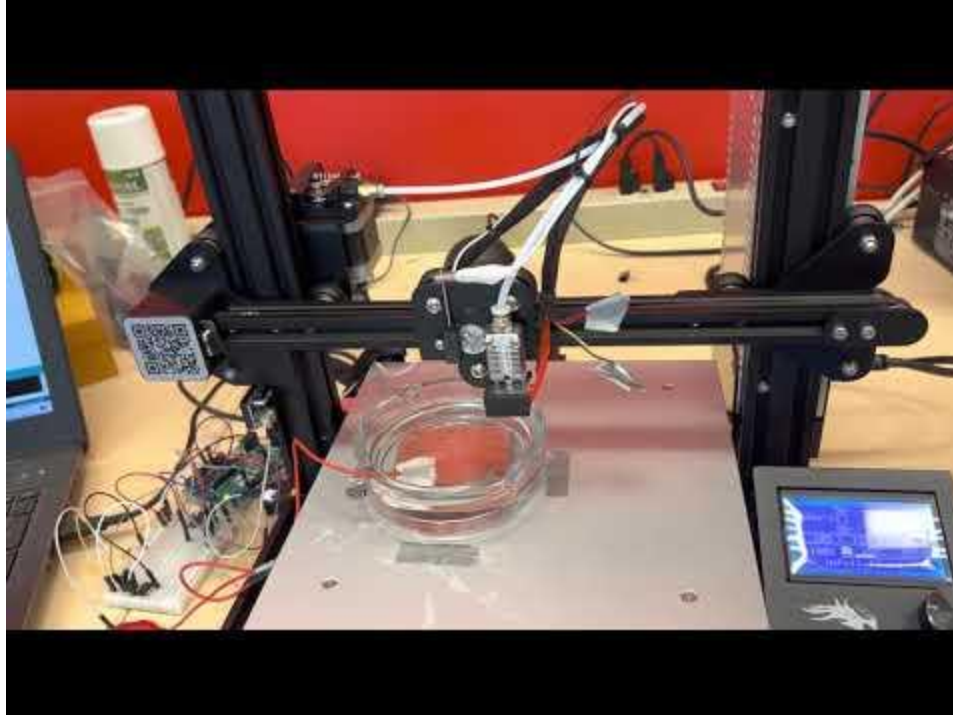
```

Starting potentiostat, aiming to hold 9 mA
9.29 mA at 3.70 V
9.78 mA at 3.72 V
8.80 mA at 3.70 V
8.80 mA at 3.72 V
8.80 mA at 3.66 V
9.29 mA at 3.72 V
9.29 mA at 3.74 V
8.80 mA at 3.68 V
8.80 mA at 3.74 V
9.29 mA at 3.76 V
9.29 mA at 3.74 V
8.80 mA at 3.68 V
8.80 mA at 3.74 V
9.29 mA at 3.76 V
9.29 mA at 3.74 V
8.80 mA at 3.70 V
8.80 mA at 3.72 V
9.29 mA at 3.74 V
8.80 mA at 3.72 V
8.80 mA at 3.74 V
9.29 mA at 3.72 V

```

Figure 5: Potentiostat UI

# Prototype Phase 2



# Conclusion and Future Remarks

- We did achieve the expected goal, a successful hydrolysis reaction using a 3D printer has been performed
- There are problems in repeatability and precision, especially with distance of anode/cathode
- We believe this creates ample opportunity for further projects to open up to improve upon:
  - Pumping & heating systems
  - More thorough testing
  - Precision improvements
  - Firmware upgrades

# Questions?

# Thank you for Attending