

ARTICULAR CARTILAGE SMOOTHER FOR ARTHROSCOPIC SURGERIES

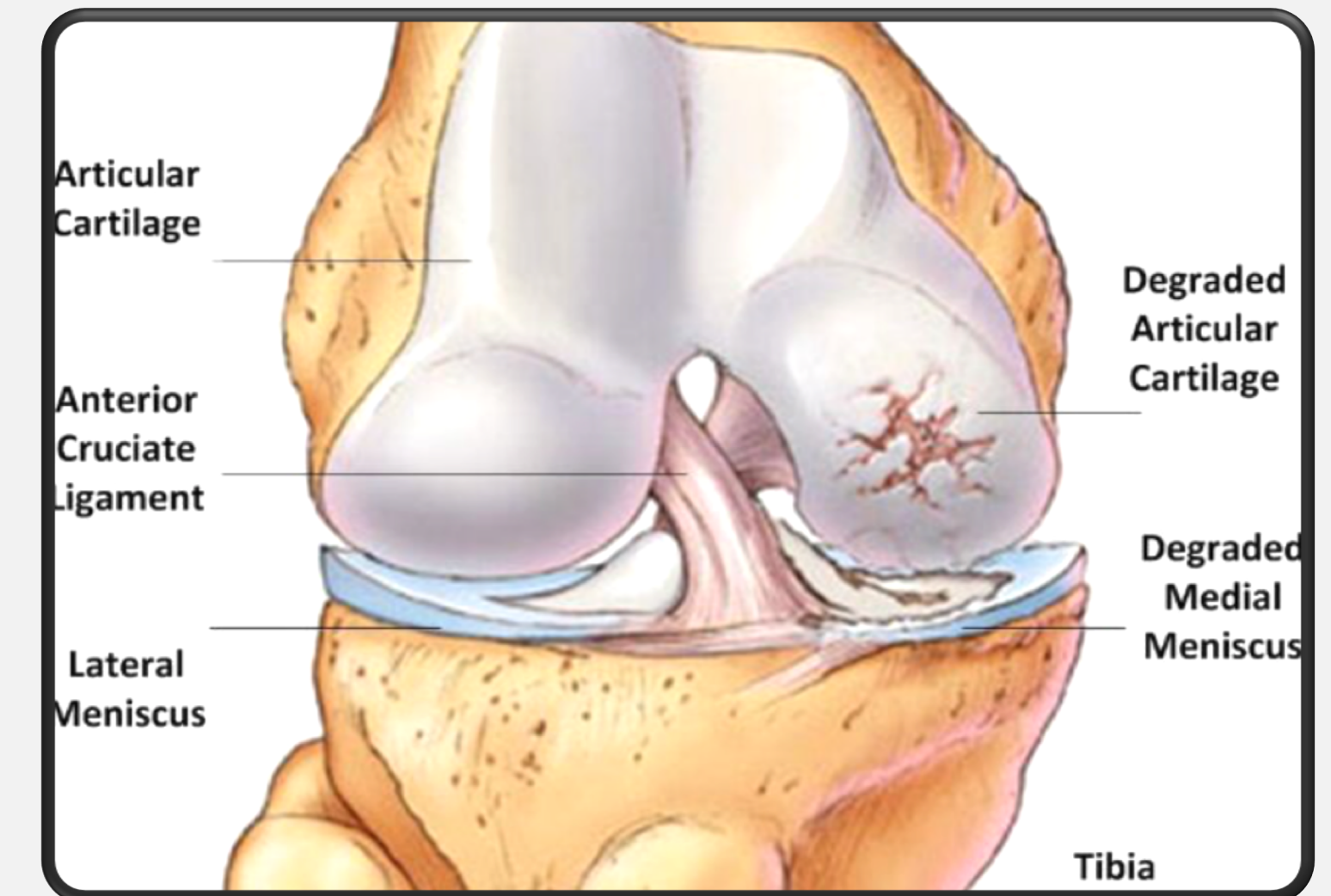
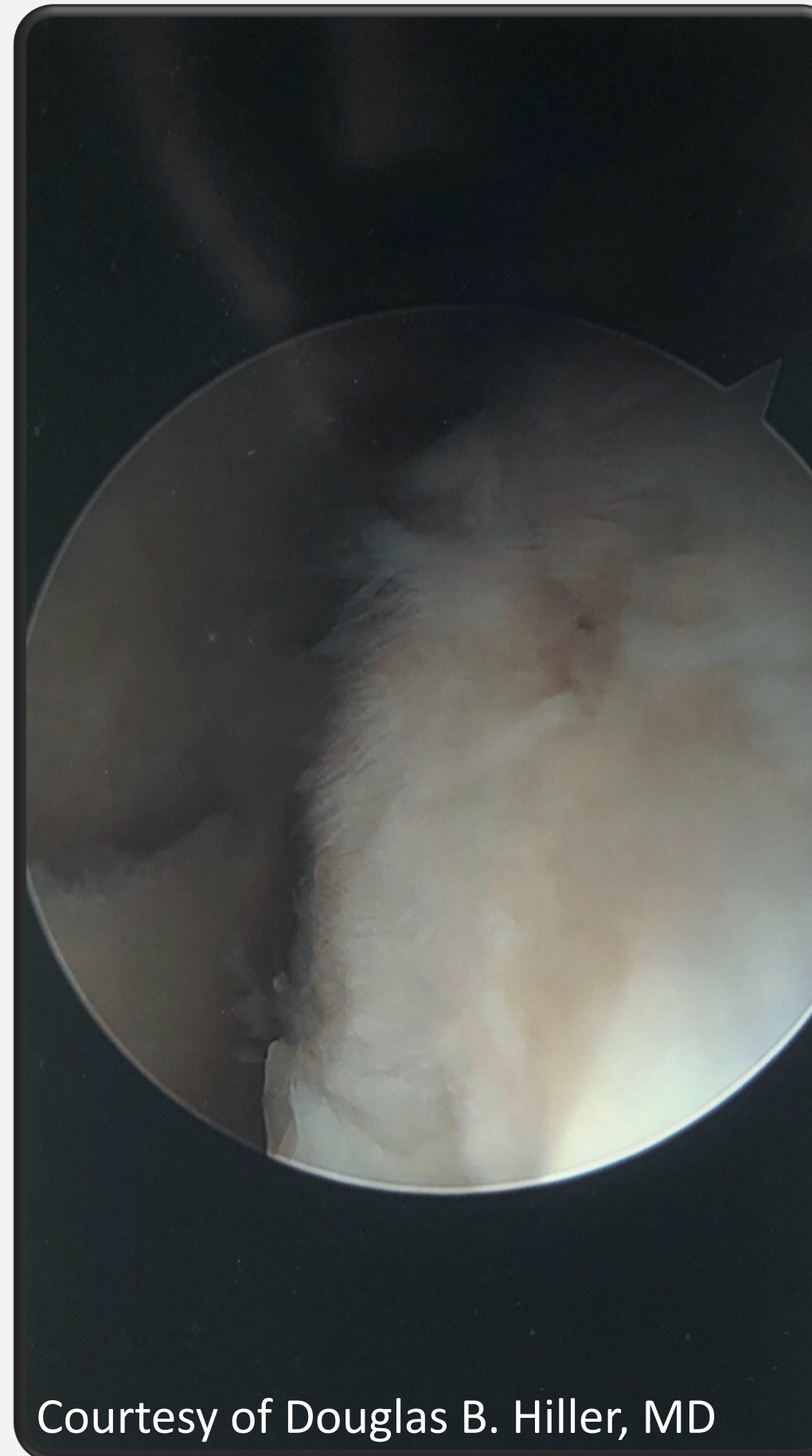
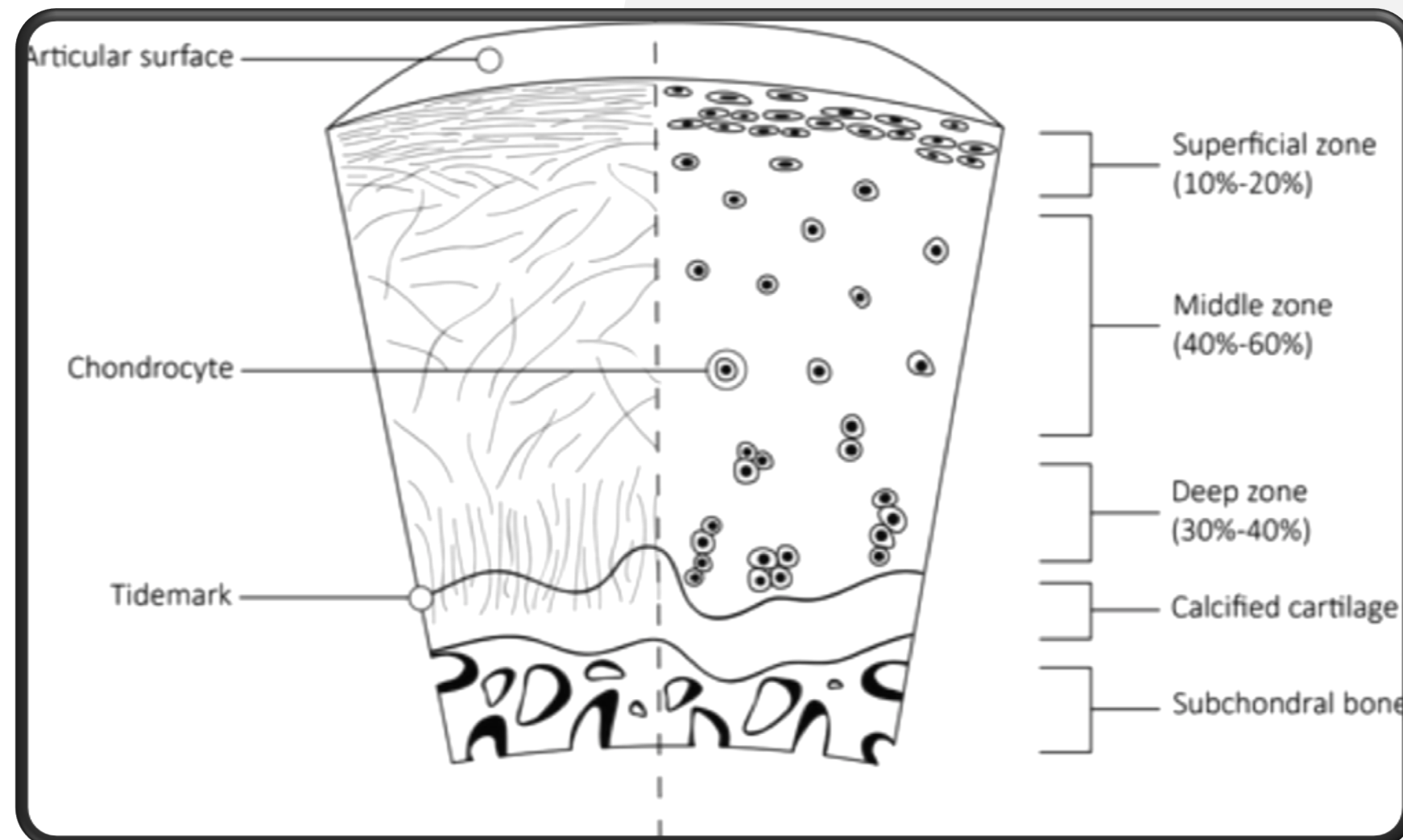
THE SCALPEL JOCKEYS

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BACKGROUND

CARTILAGE



PROBLEM DEFINITION

SURGICAL INTERVENTIONS

- I Perform total joint replacements
- I Arthroscopic debridement

PROBLEM STATEMENT

We were tasked with designing a device to address the underlying issues presented when performing arthroscopic debridement. Current shavers utilize a rotating drum-shaped shaving head that, when pressed against cartilage or bone, can cause ripples, which creates a suboptimal post-surgical result.

VALUE PROPOSITION

OBJECTIVE:

Our team is driven to optimize arthroscopic debridement by creating a vibrational arthroscopic smoothing device that creates smoother articular surfaces, which results in a post-surgical joint that provides an improved quality of life for patients.

INNOVATIVE GOAL:

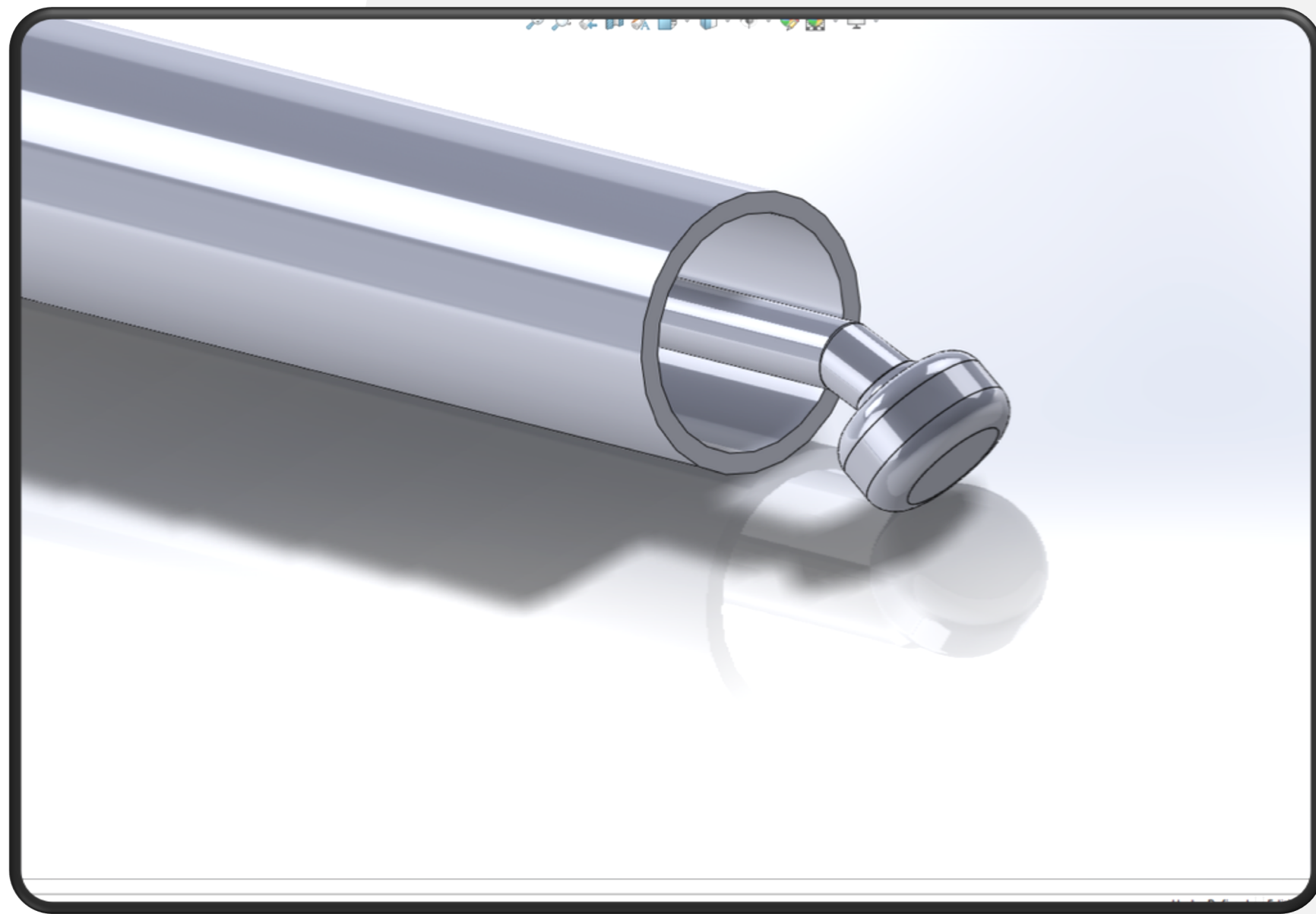
To improve the lives of orthopedic surgeons by creating a more ergonomic and functional device than the current technologies.

PROJECT REQUIREMENTS

- I Comfortable and lightweight
- I Shaft diameter of less than 5 mm
- I Biologically compatible materials
- I Autoclavable
- I Compatible with suction and fluid flow
- I Creates smooth articular surface

APPROACHES CONSIDERED

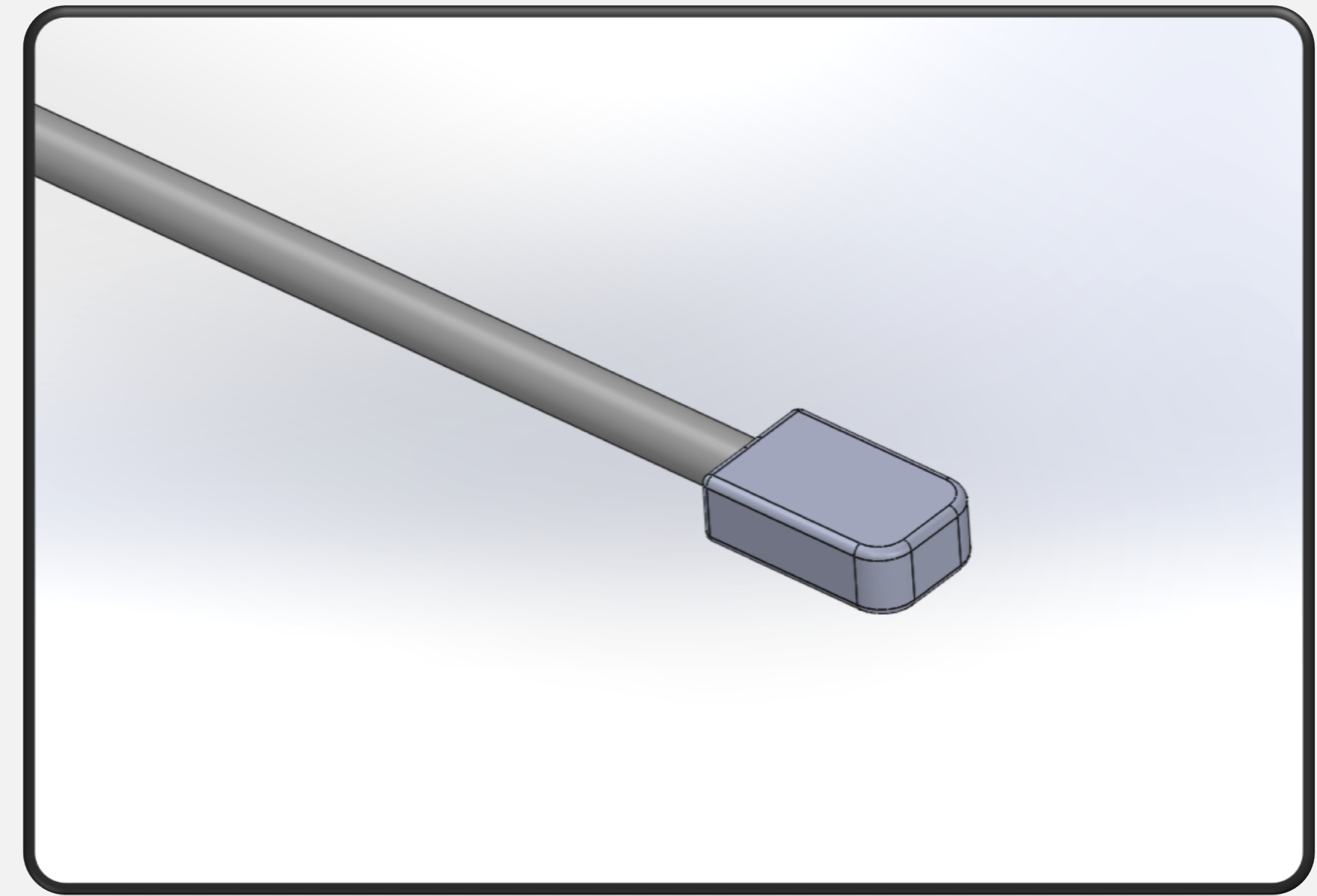
BALL & SOCKET



I Concerns:

- Challenging to manufacture on small scale
- Difficult to control and position

FIXED HEAD



I Solutions:

- Easier to manufacture
- Large fillets on edges

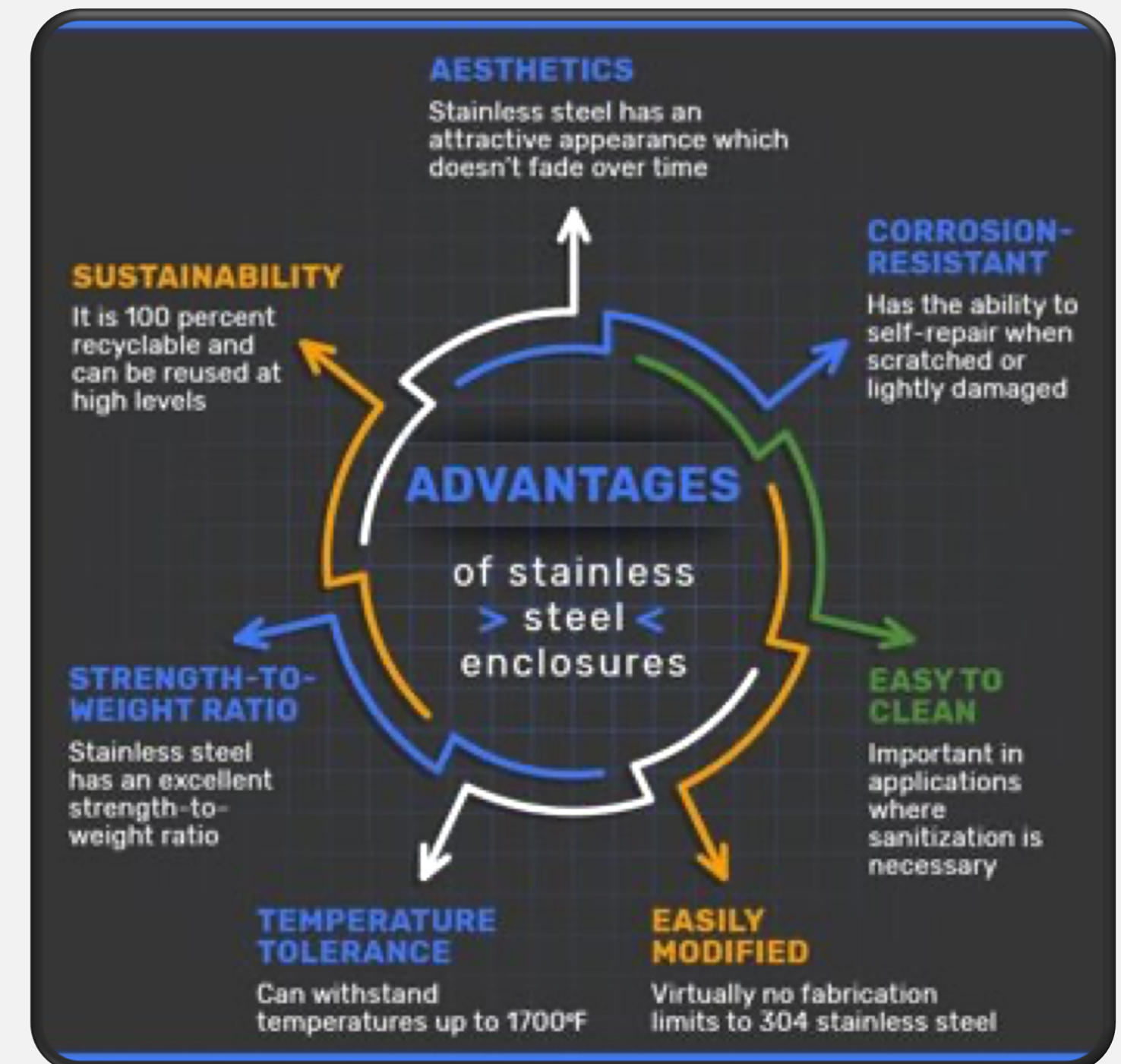
MATERIAL SELECTION

I Outer suction shaft – Aluminum

- High strength to weight ratio, non-toxic, inexpensive, and sterilizable
- Common in handles and bodies of surgical instrument
- Should be coated to reduce corrosion

I Inner driveshaft and head – 316L "medical grade" stainless steel

- Less expensive than titanium
- Strong, yet able to be gritted through sandblasting or lapping
- Common in surgical instruments
- Corrosion resistant in aqueous and saline environments

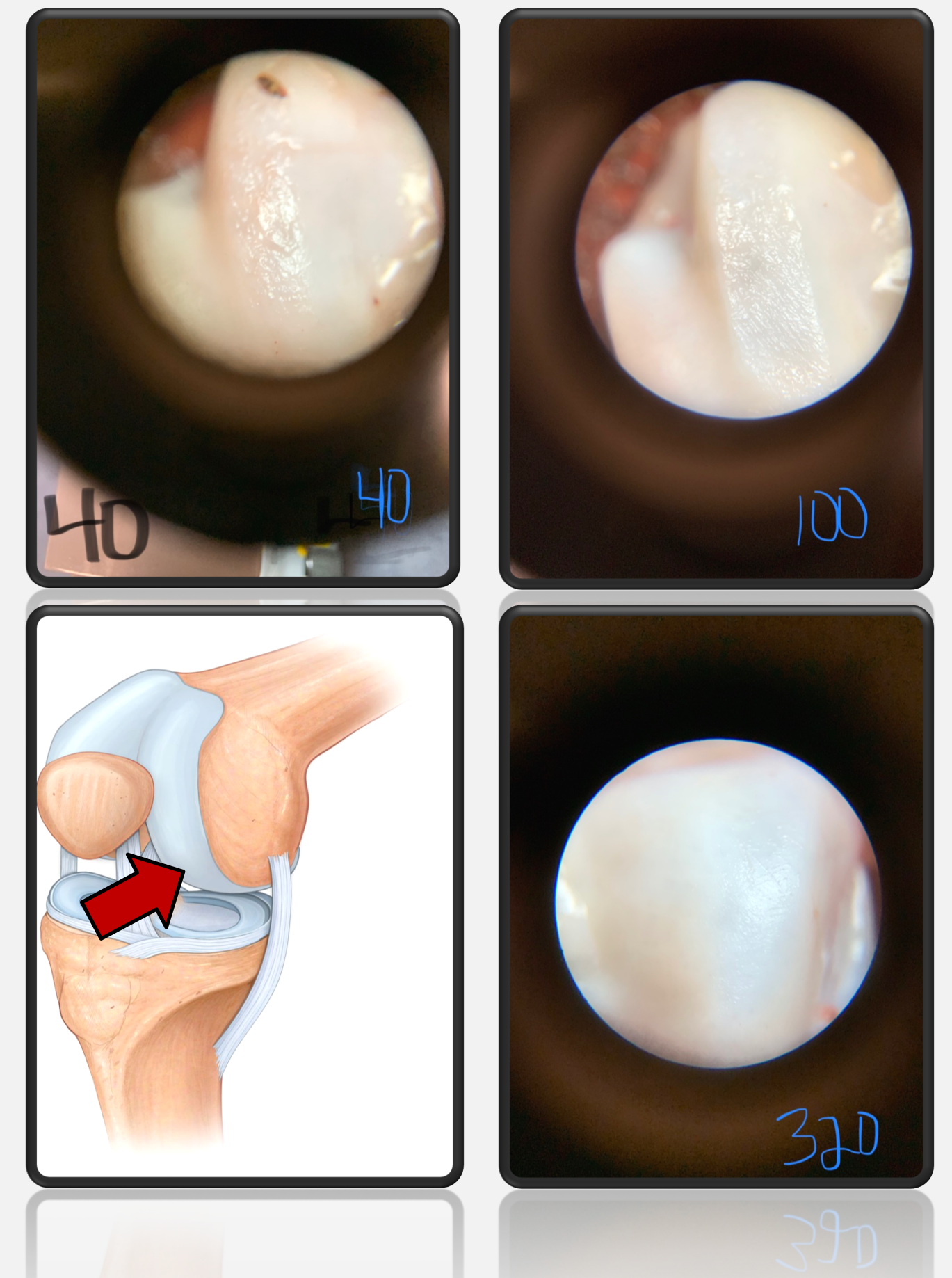


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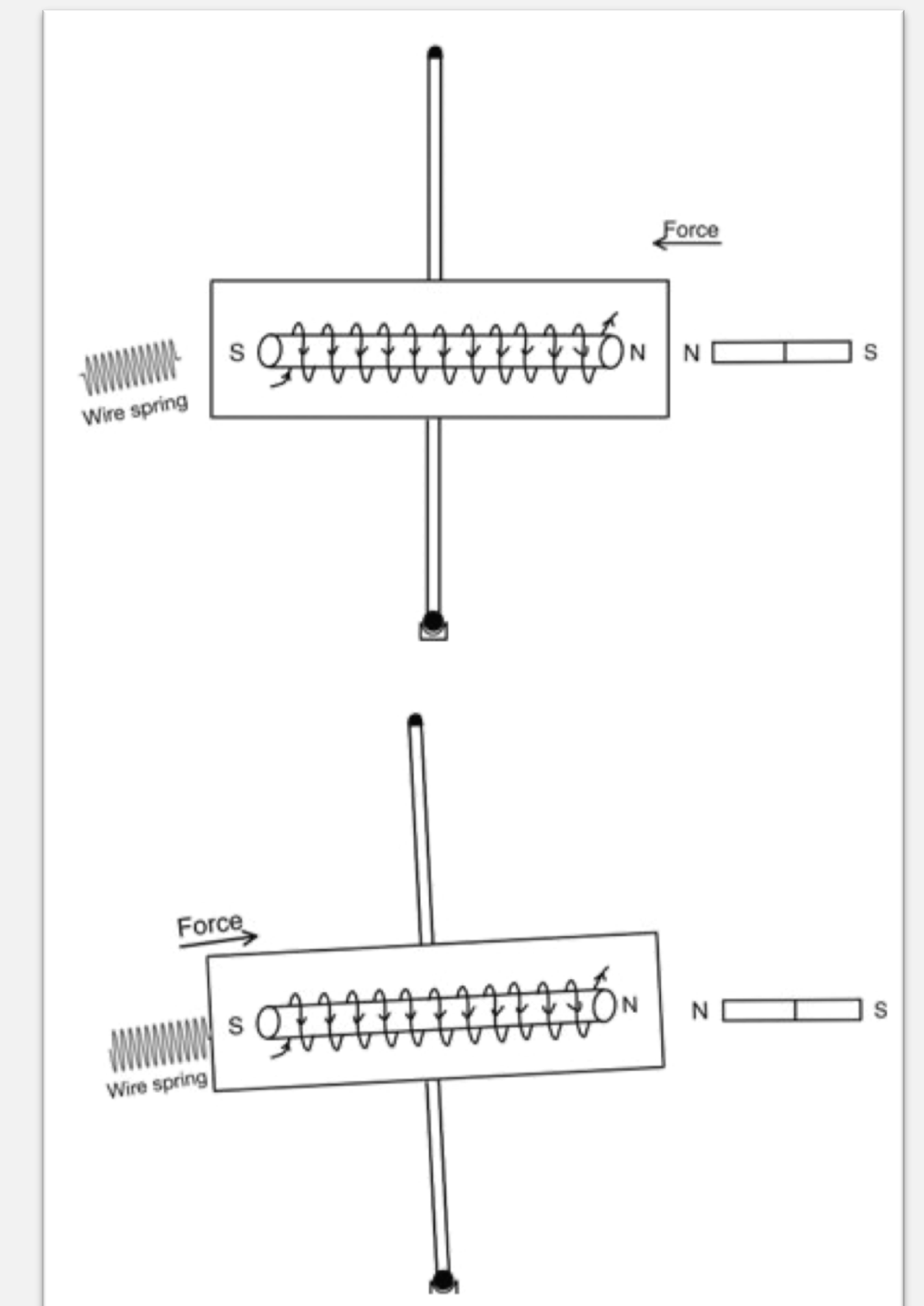
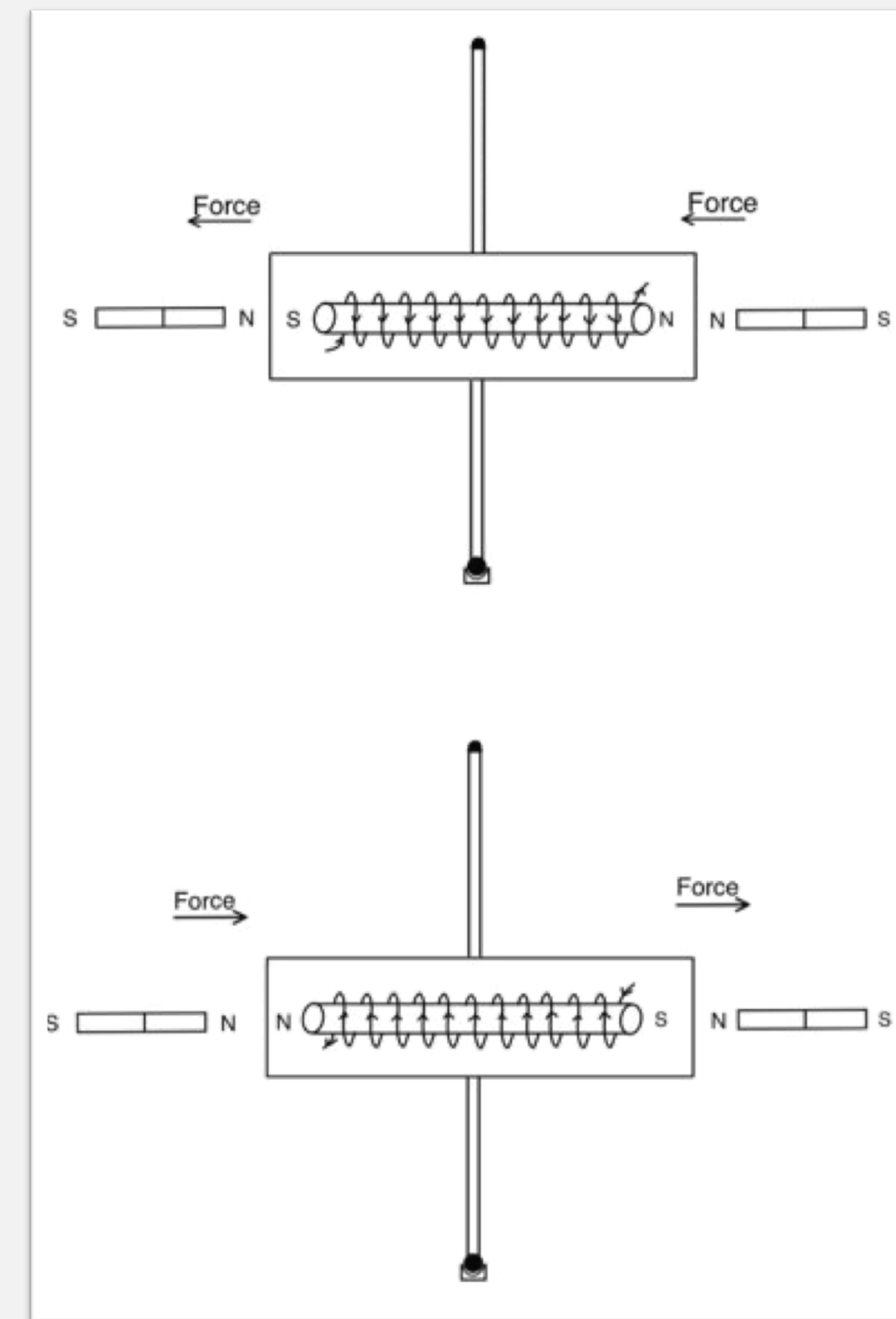
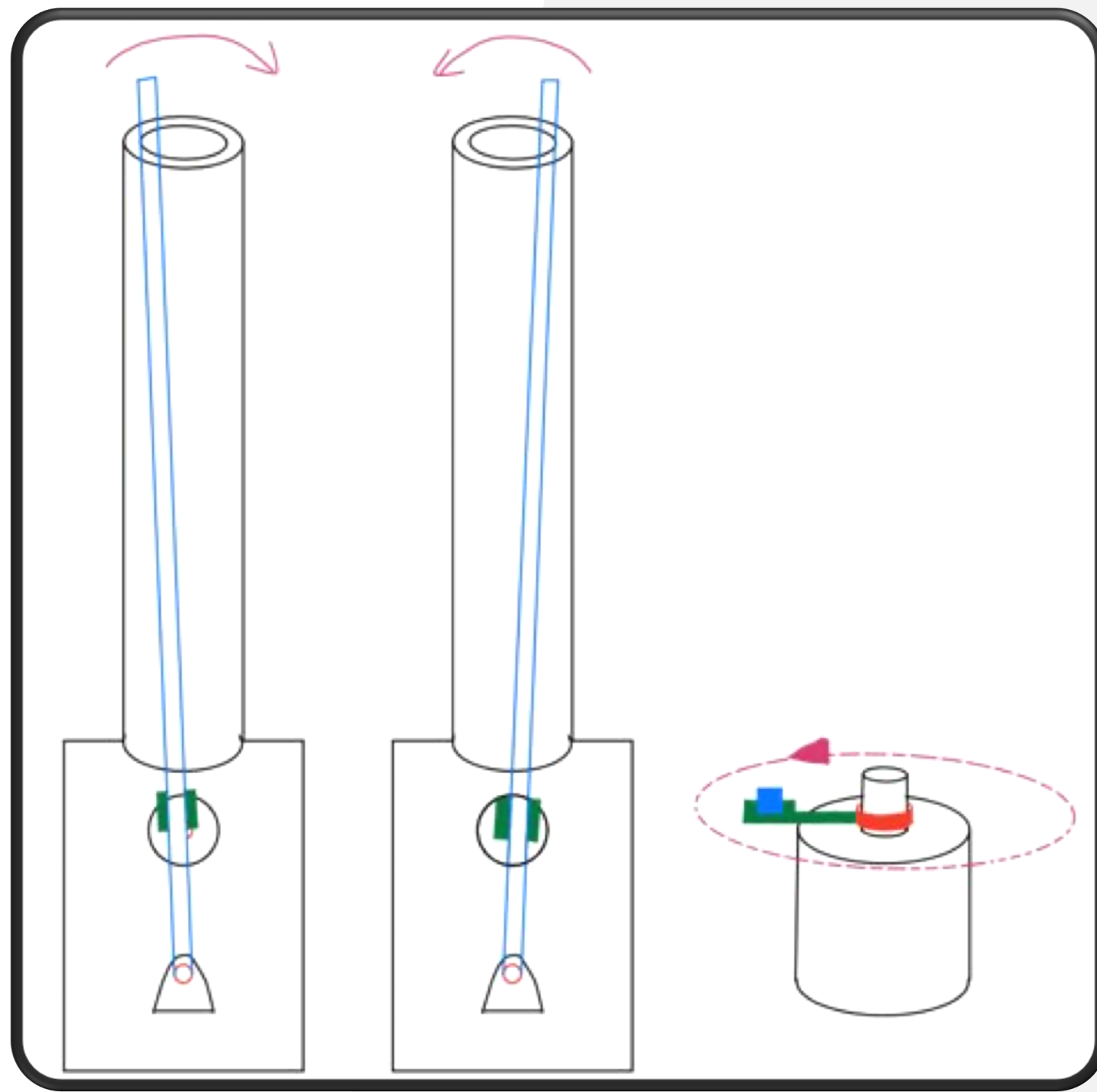
GRIT SELECTION

UTILIZING CHICKEN BONES AS TEST SUBJECTS

- I Chicken femoral condyles
- I Grit selection using sandpaper
 - 300+ produced visibly smoothest result from 8 grits tested



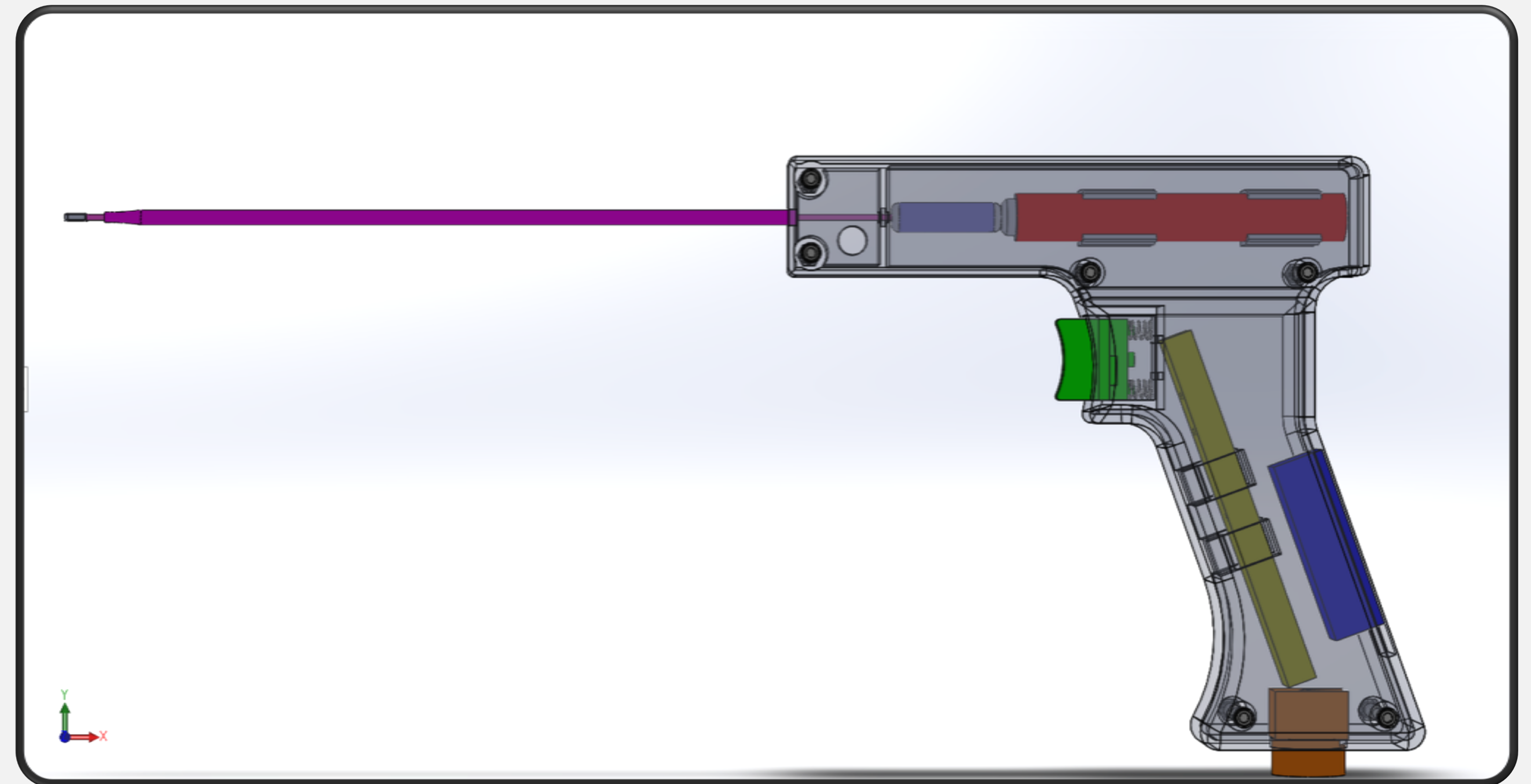
INITIAL IDEAS FOR PRODUCTION OF VIBRATION



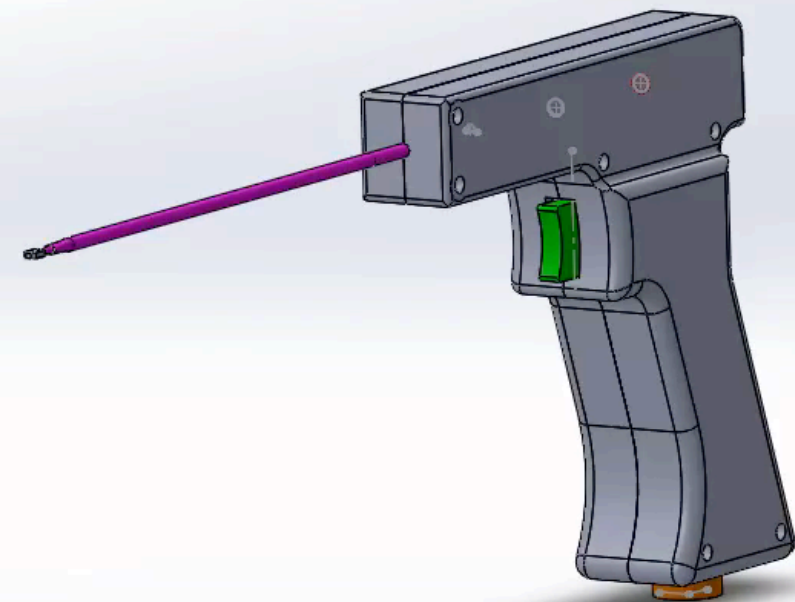
FINAL DESIGN - ASSEMBLY

I Assembly includes:

- Driveshaft / Smoothing Surface (Pink)
- Outer Shaft (Pink)
- Fluid Chamber
- Connector Jacket (Purple)
- Motor & Clips (Red)
- Trigger / Springs / Push Button (Green)
- Circuit Board (Yellow)
- Battery Compartment (Blue)
- Charger Placement (Orange)
- Nuts & Bolts for fastening
- 3D-Printed Encasing Handle



FINAL DESIGN DETAILS



- I Fluid flow facilitated through outer shaft and chamber
- I Ergonomic handle design
- I Adapter from motor to driveshaft
- I Spring-levered trigger control
- I Rechargeable battery compartment

ELECTRICAL CIRCUITRY

- I Simple code to control vibration
- I Ran into problems with button functionality
- I Edits resolved problems, now one push of button turns vibration on, another push turns it off

```
int pushbutton;
bool isON;
unsigned long Time;

void setup() {
  pinMode(11, OUTPUT);
  pinMode(12, OUTPUT);
  isON=false;
  pushbutton=0;
  Time = millis();
  attachInterrupt(0, ToggleState, RISING);
}

void loop() {

  if (isON) {
    digitalWrite(11, HIGH);
    digitalWrite(12, LOW);
    delay(2);
    digitalWrite(11, LOW);
    digitalWrite(12, HIGH);
    delay(2);
  }

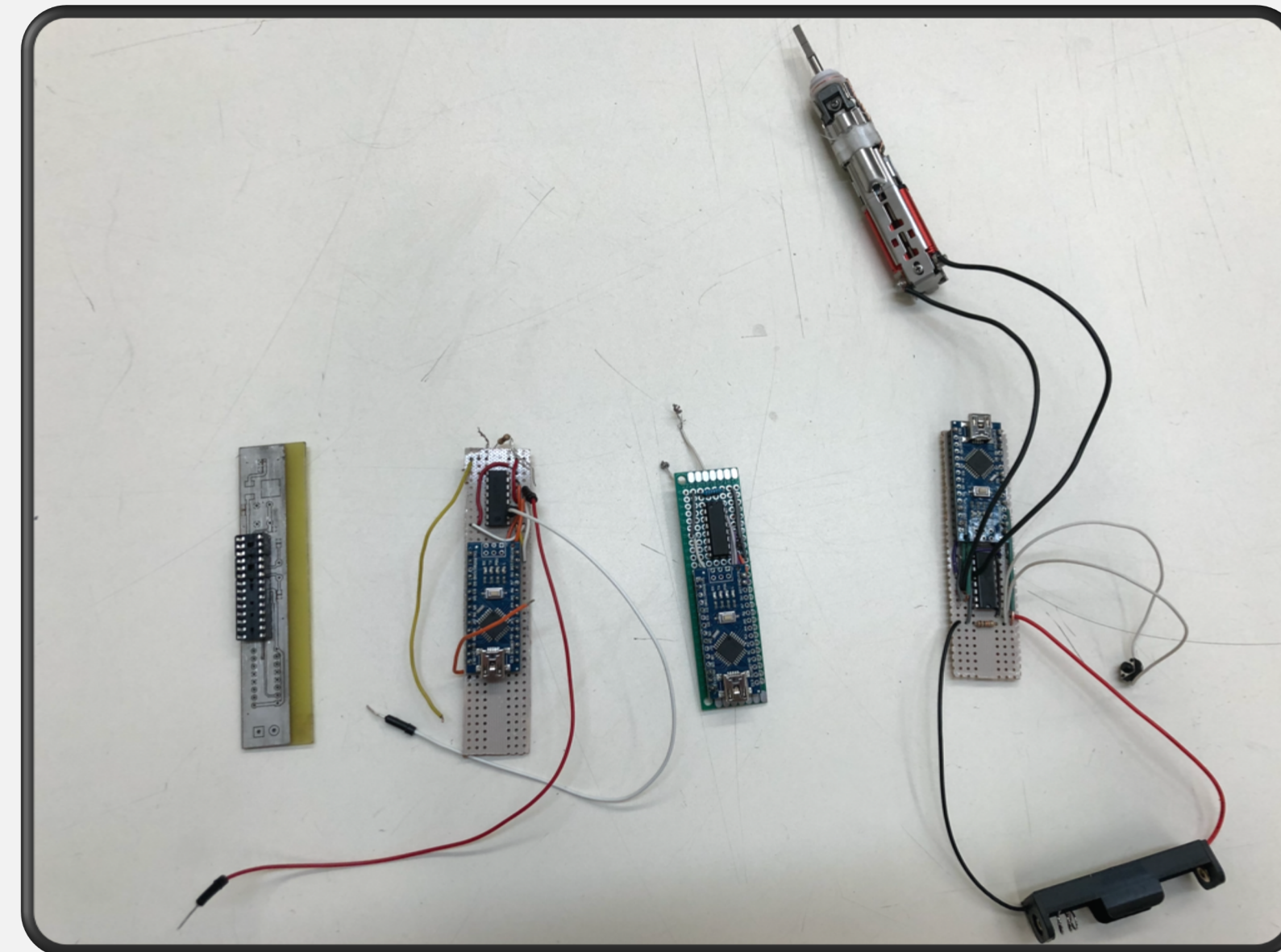
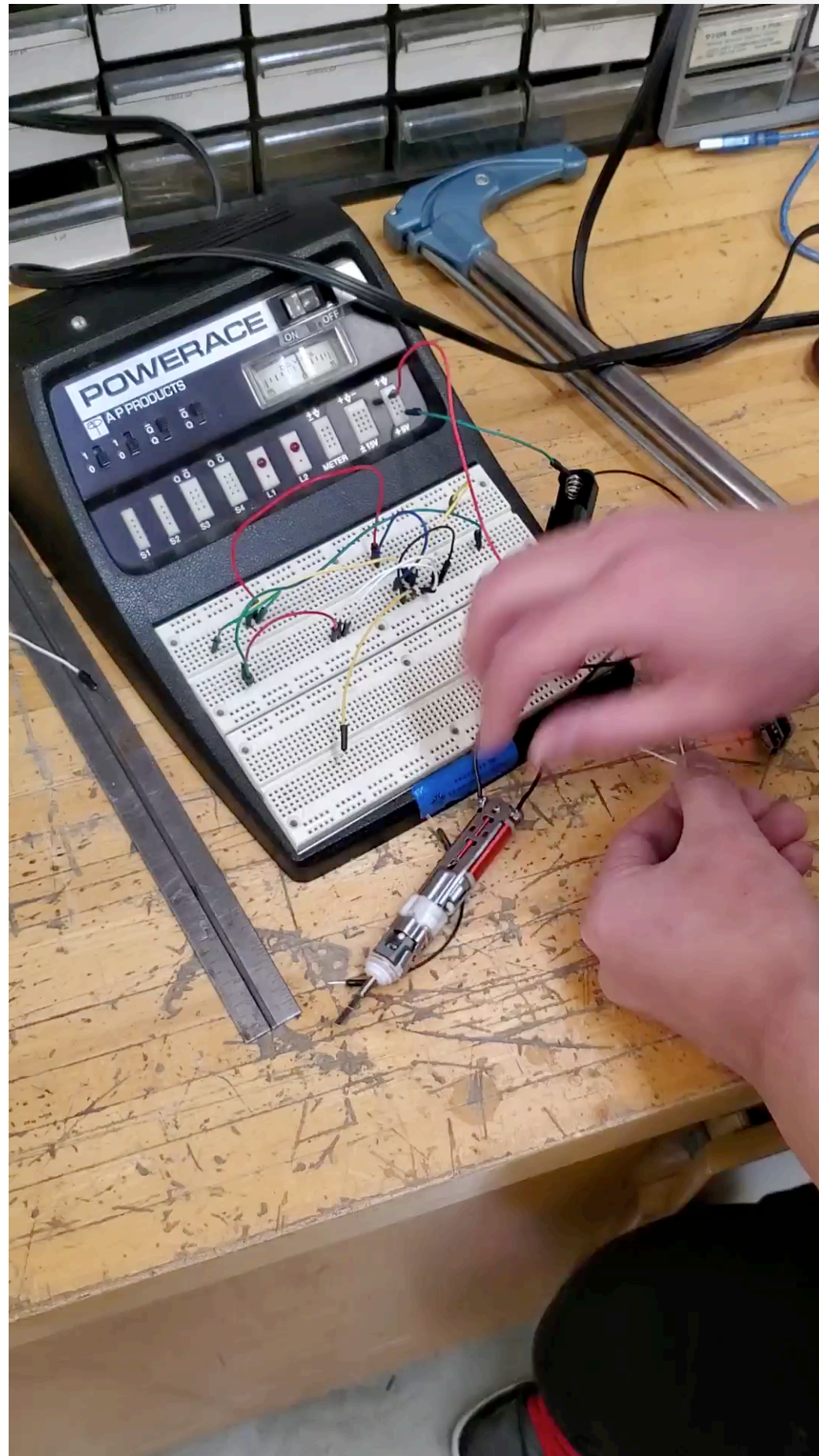
}

void ToggleState() {

  if ((millis() - Time) > 200) {
    isON=!isON;;
    Time = millis();
  }

}
```

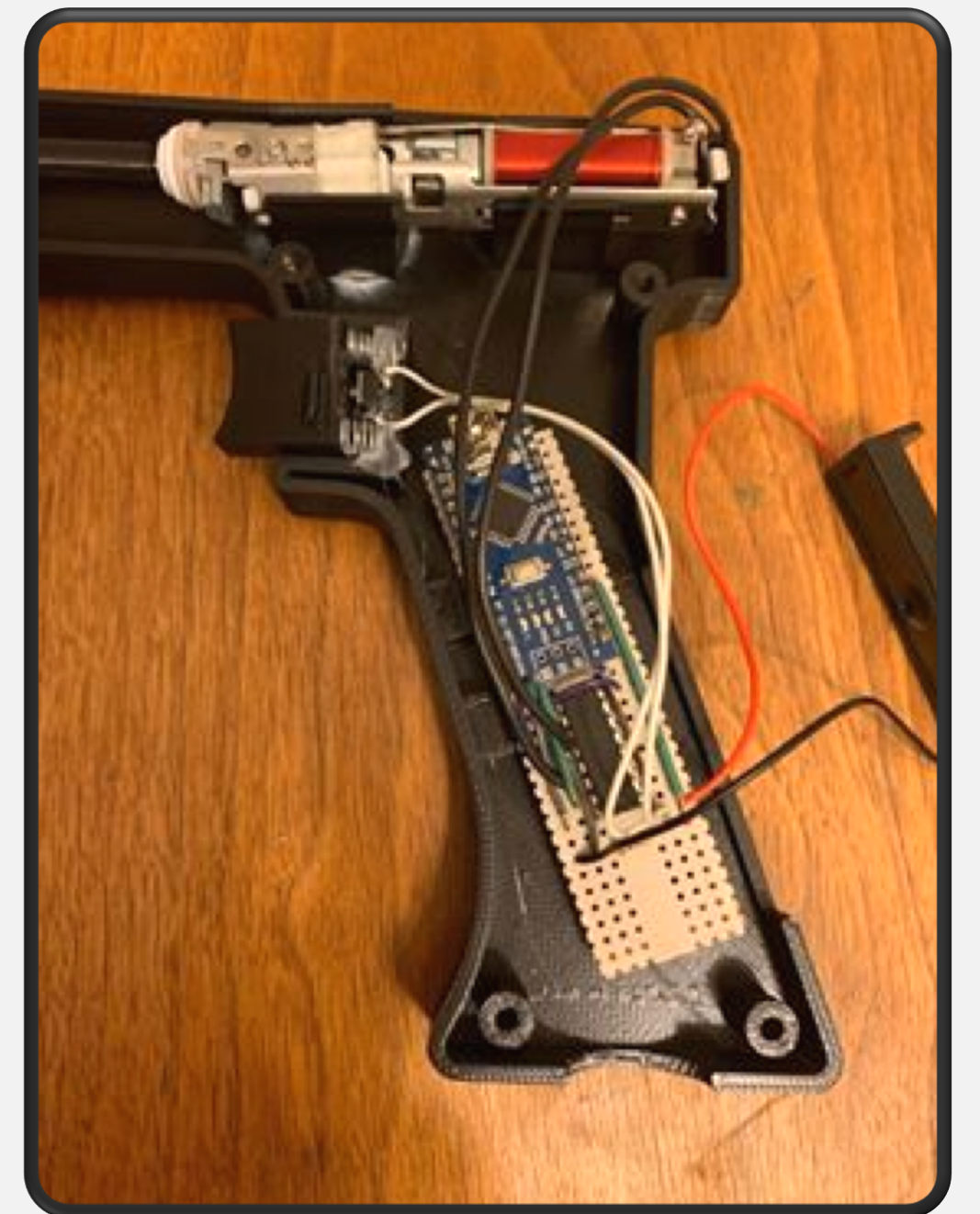

ELECTRICAL CIRCUITRY



- Iterations of circuit board

- I Vibrational motor
 - Simpler than other approaches mentioned
- I Microcontroller (Arduino Nano)
- I Period = 4ms, $f = 250 \text{ Hz}$, $V = 3.7\text{V}$ (from rechargeable battery)
- I H-bridge controls waveform of circuit

FINAL PROTOTYPE



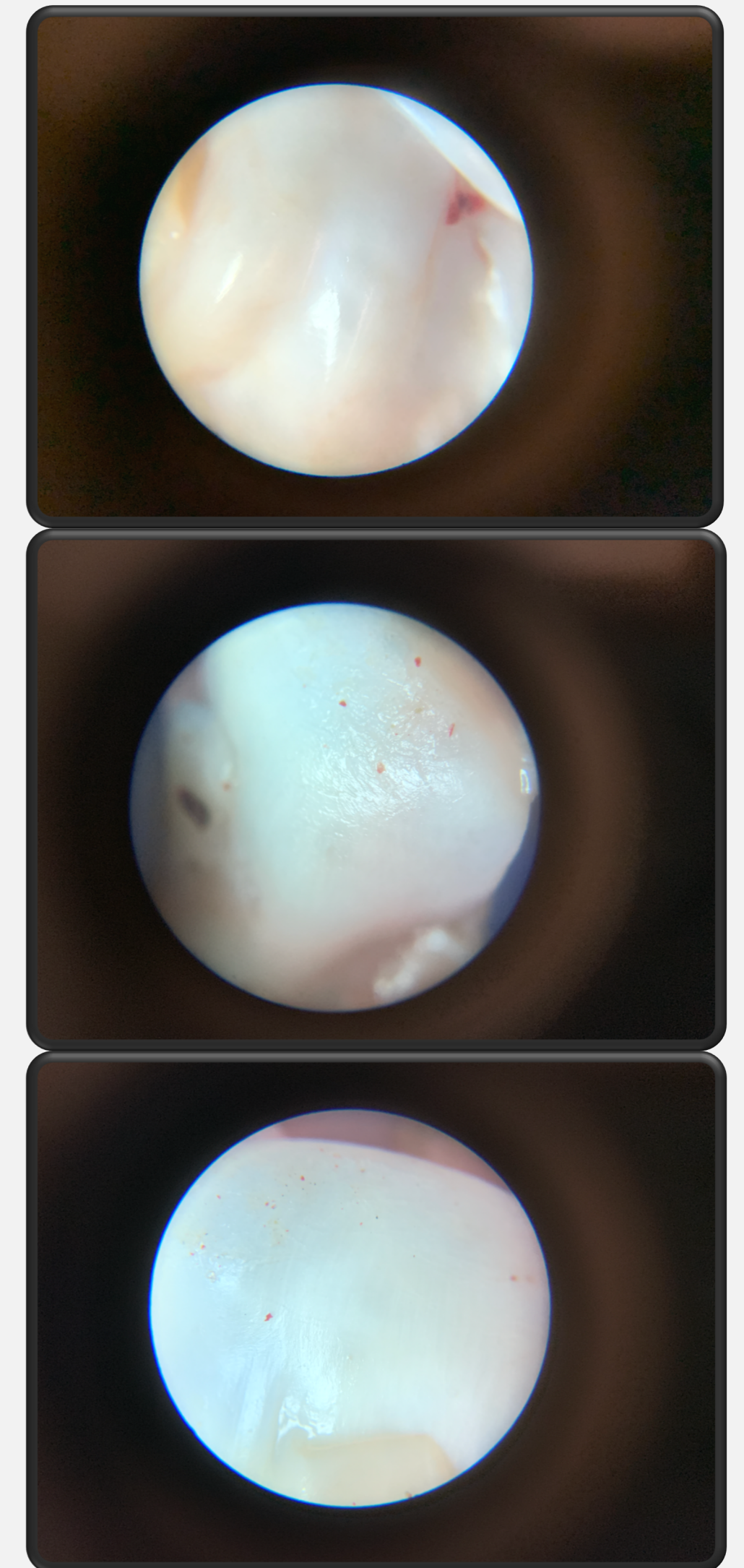
SURFACE VALIDATION

MORE CHICKEN BONES

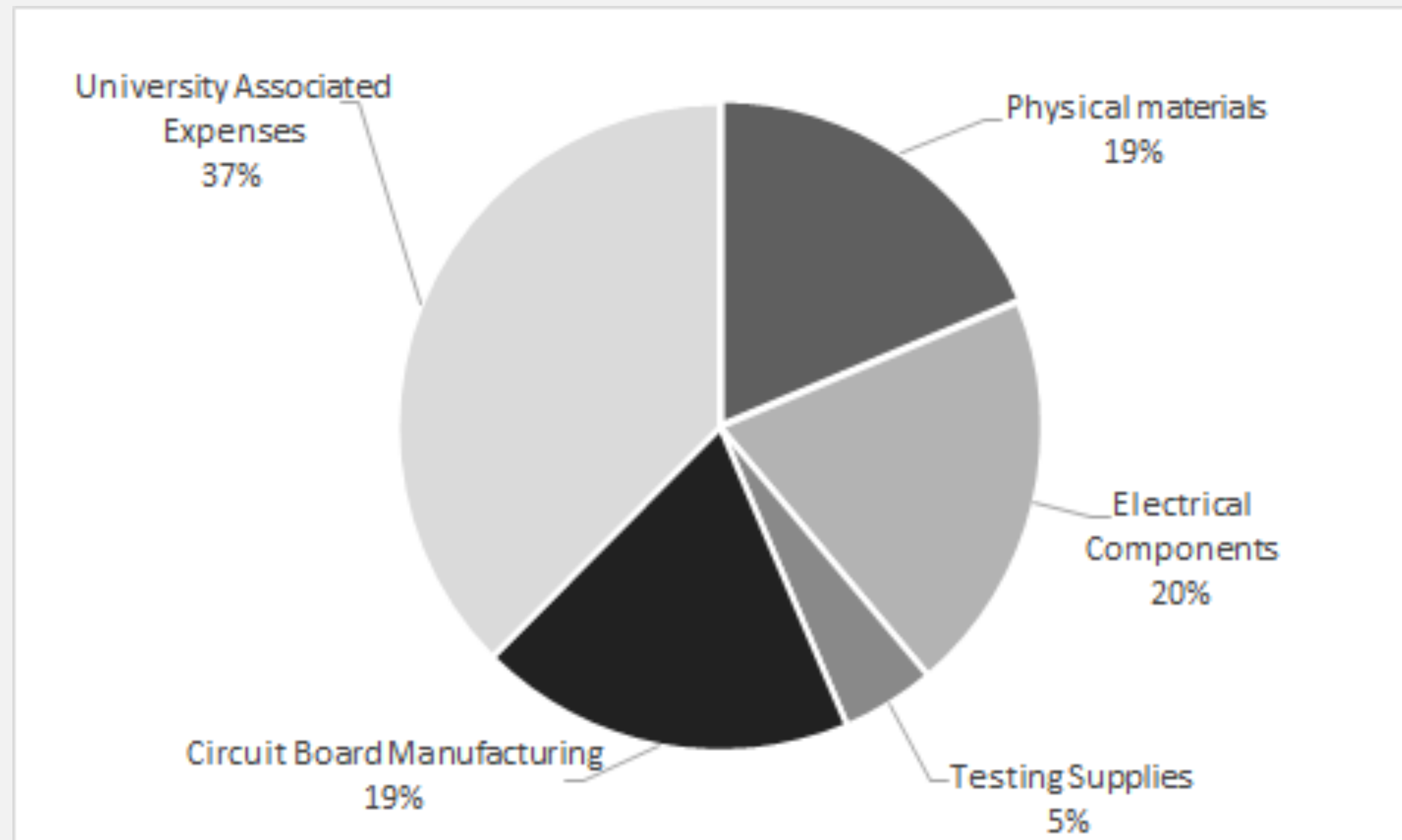
I Validation of motor setup and smoothing ability

- Used 40 grit sandpaper to mimic tissue damage
- Used Dremel head to mimic smoothing head of device

I Top to bottom: Healthy tissue, damaged tissue, treated tissue



PROJECT BUDGET



Total Budget: \$3000
Actual Spent: \$1188

FUTURE WORK

I Further testing on suction mechanism

I Use of more advanced microscopy

I Smoothing head design

- Detachable convex and concave designs

I Outsource Manufacturing

LONG TERM:

I In vivo trials

EXPO

engineering ▲ design



University of Idaho
College of Engineering

QUESTIONS?

For more information:

