

Smooth Sanding Device For Arthroscopic Surgeries

Jett Murray, Maclean Landis, Lucas Dibelius, Ryan Crowell

Objective

The goal of this project is to create a reliable and safe arthroscopic sanding device that utilizes a random orbital motion with reusable and interchangeable tooltips that shave rough arthritic joint surfaces smooth to reduce need for total knee replacement, lessen pain and lower post-operation rehabilitation time.

Background

- Osteoarthritis (OA) is a characteristic roughening of the joint, causing chronic pain and inflammation
- ~750k knee arthroscopies occur annually in US for OA pain mitigation, but costs are high due to single-use tooltips



- Commonly used arthroscopic shaver heads (shown above) often leave grooves in the areas that have been shaved. This causes irritation of the joint tissues and leads to a longer period of rehabilitation.

Value Proposition

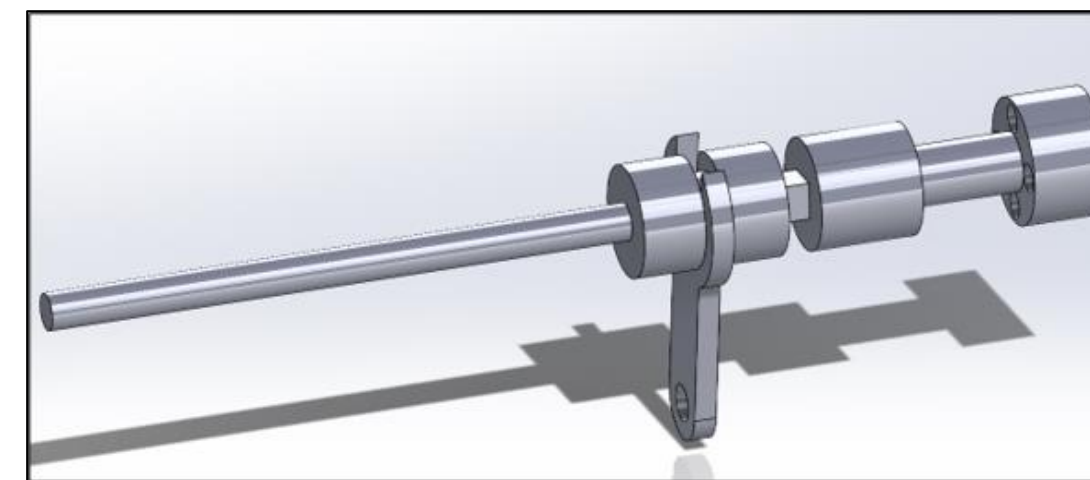
- Currently, no technology exists to re-shape damaged joint surfaces, which could lower patient rehabilitation times
- This device aims to create a random-orbital sanding platform for OA arthroscopic surgeries to improve patient outcomes
 - Allow reshaping of bone and cartilage to treat OA pain
 - Incorporate reusable tooltips to reduce patient costs

Key Requirements

- Variable output speed from 900-6000 RPM
- Random orbital sanding hypoallergenic tooltips
- Corrosion-resistant tooltip/output shaft of 4mm diameter
- Compatibility with modular tooltips
 - Different grits
- Reliable 2-hour battery life with modular power supply
- Compatibility with existing surgical suction devices
 - Debris (bone/cartilage) removal
- Reusable device with reusable tooltips capable of sterilization
 - Autoclavable

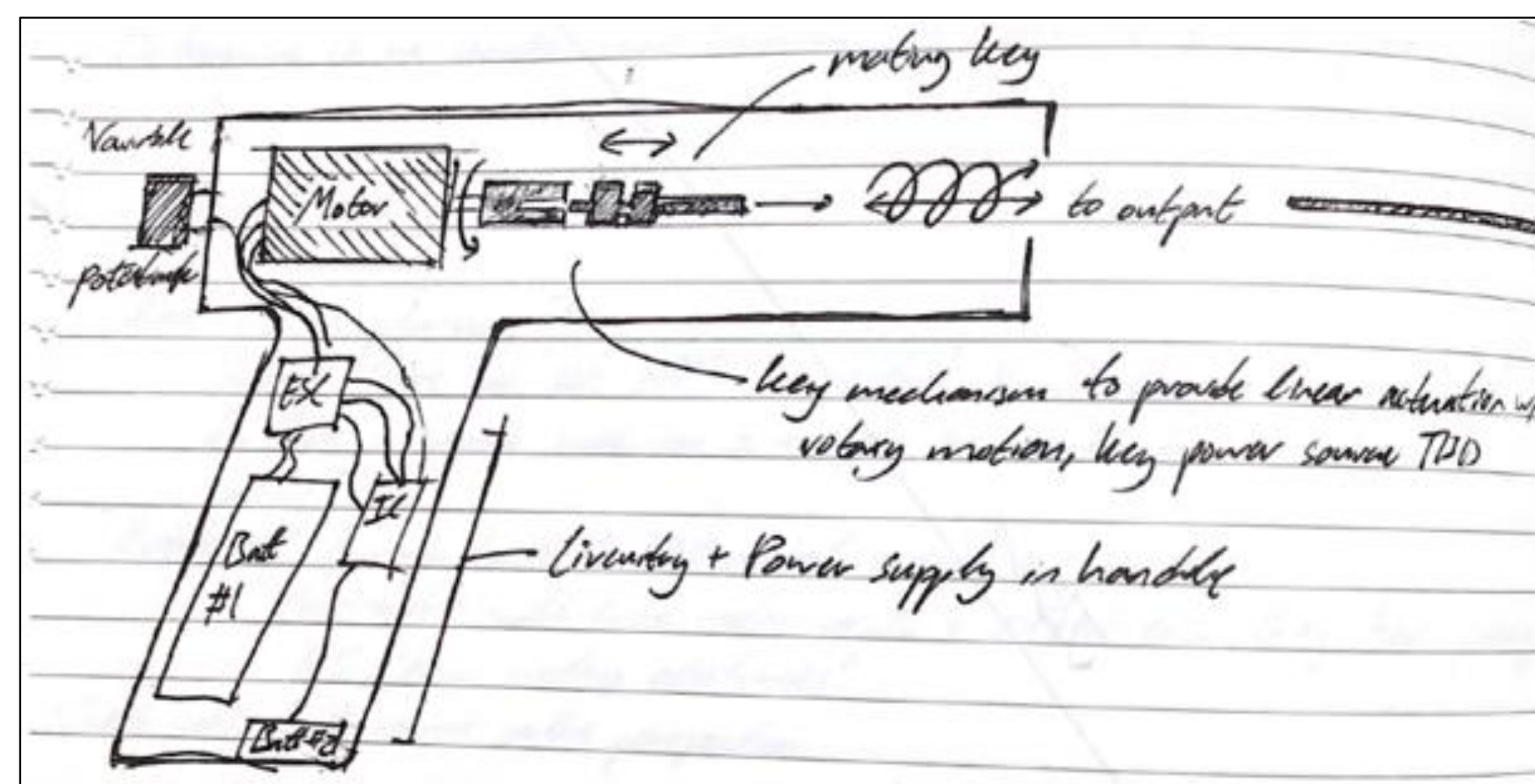
Concept Development

- Two initial designs: Sawzall DC motor and linear actuator, fixed DC motor with linear solenoids
- Reliability concerns directed to second option
- Completed circuit and coding
- Inner mechanism CAD done
- 3D Printed scaled models
- Handle test bed for DC motor
- CAD handle in progress
- Awaiting purchased parts to begin prototyping with solenoids on test bed



The Final Design

- Design functions with DC motor mounted linearly to the rotating shaft, conjunctive to 4 micro solenoids working in tandem to create linear actuation

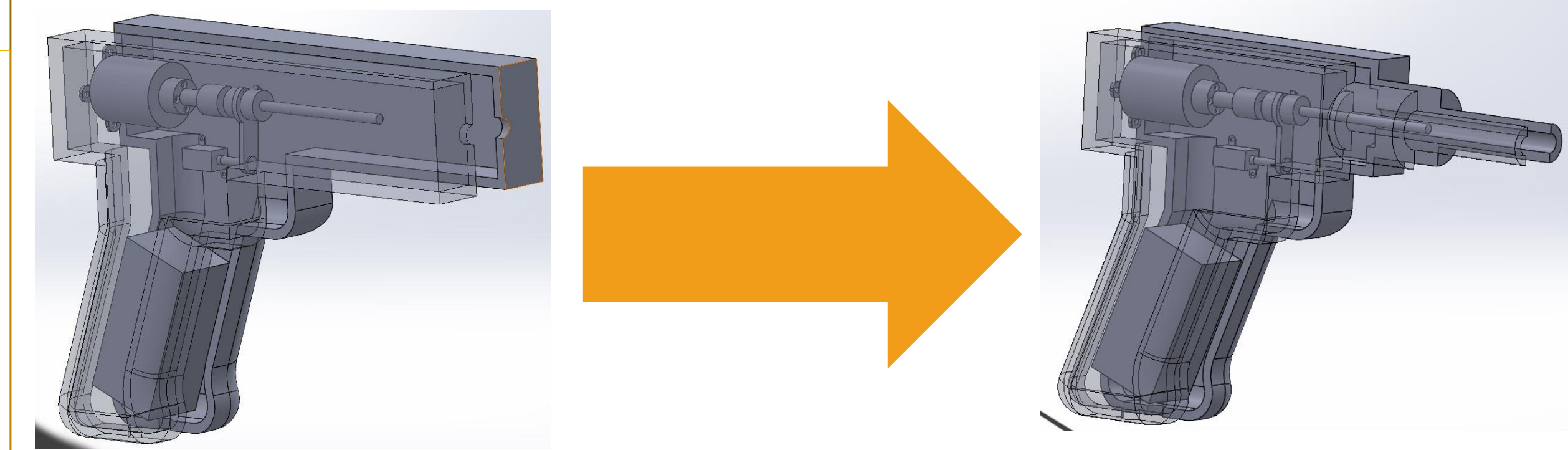


- Achieves linear and rotational motion
- Potentiometer controls revolutions, toggle to activate
- Cylindrical rounded shaving head, sand blasted
- Prototype #1
 - 3D printed handle and inner orbital sanding mechanism
 - Stock metal outer rod, inner rod 3D printed
 - Potentiometer and toggle activation
 - Enclosed battery and circuitry
 - Limited head sanding potential
- Final Prototype
 - Machined handle and inner orbital sanding mechanism
 - Handle from stainless steel, inner rod and head from stainless steel, outer rod from aluminum with non-corrosive coating
 - Sandblast head, full sanding capability

Validation

To determine the functionality of our early-stage prototype we have put the machine through a few tests:

- Solenoid strength testing results: repeating four different times we reached an average pulling strength of 255 grams
- Shaft actuation testing results: repeating this several times we reached a conclusion that the shaft needed 100 grams in line with shaft
- We went through various CAD models to ensure that the model was best suited for surgical use. Considerations included comfortability, weight balance, and visibility



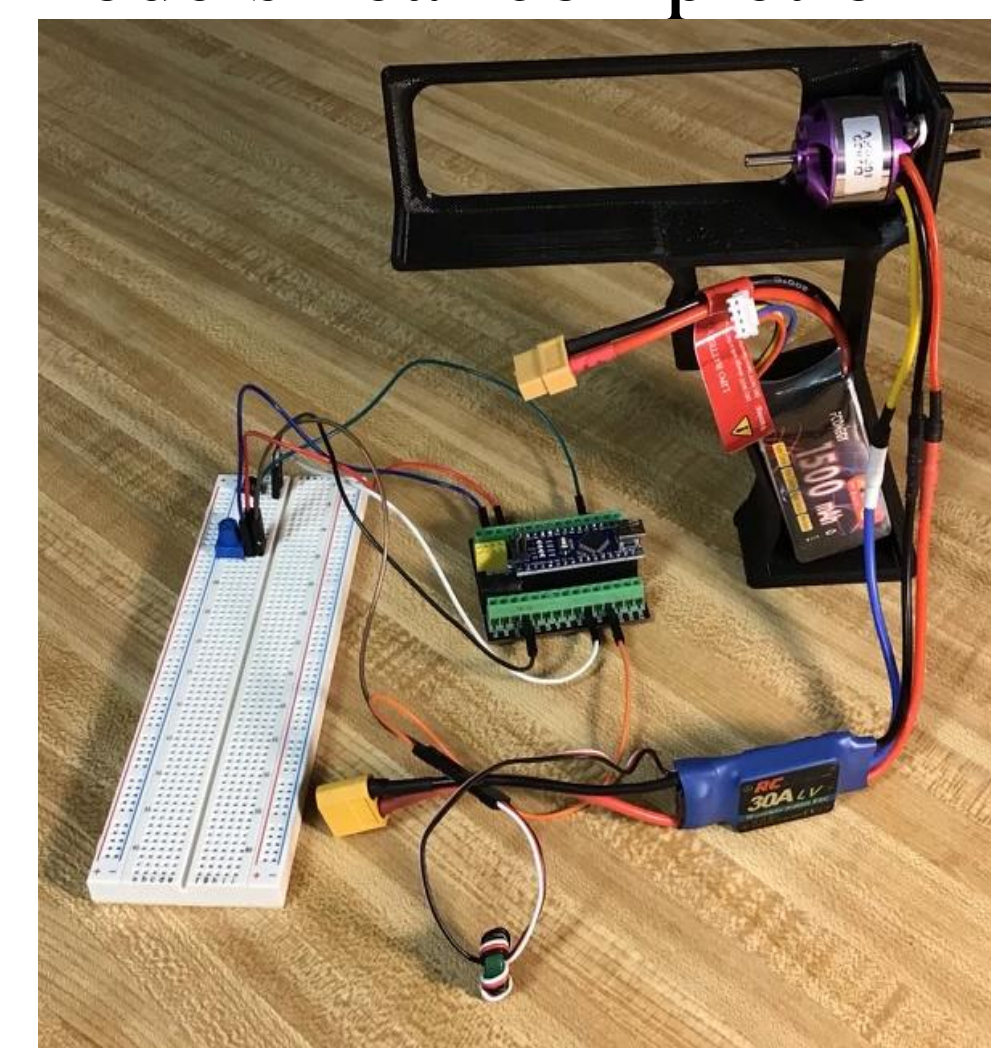
- Actuation fork for the shaft creates a moment that can cause the motor to fail
- Spring does not have required force to pull fork back
- Upcoming tests: battery longevity, contact testing, comfortability quality testing,

Summary, Conclusions, and Recommendations

- Solenoid concerns lead us to using four solenoids using two-sided actuation fork (in front and behind fork both above and below it)

With motors up and running and CAD models near completion next steps will be:

- Designing and testing shaver heads
- Machining CAD model
- Machining shaft actuation parts
- Ensuring autoclavability
- Compare performance of shaver with commonly used shavers
- Performing final tests to ensure Shaft stays perfectly steady in use



Acknowledgements

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