GearHub Cordage Compiler

THIS OPPORTUNITY FOCUSES ON ASSISTING INDIVIDUALS WITH OSTEOARTHRITIS WITHIN THE TORONTO GUILD OF SPINNERS AND WEAVERS TO MAKE CORDAGE-MAKING LESS STRENUOUS

What is Cordage Making?

The process of twisting two strands of reed and then plying them together to create a rope. This rope is then used in the weaving process.

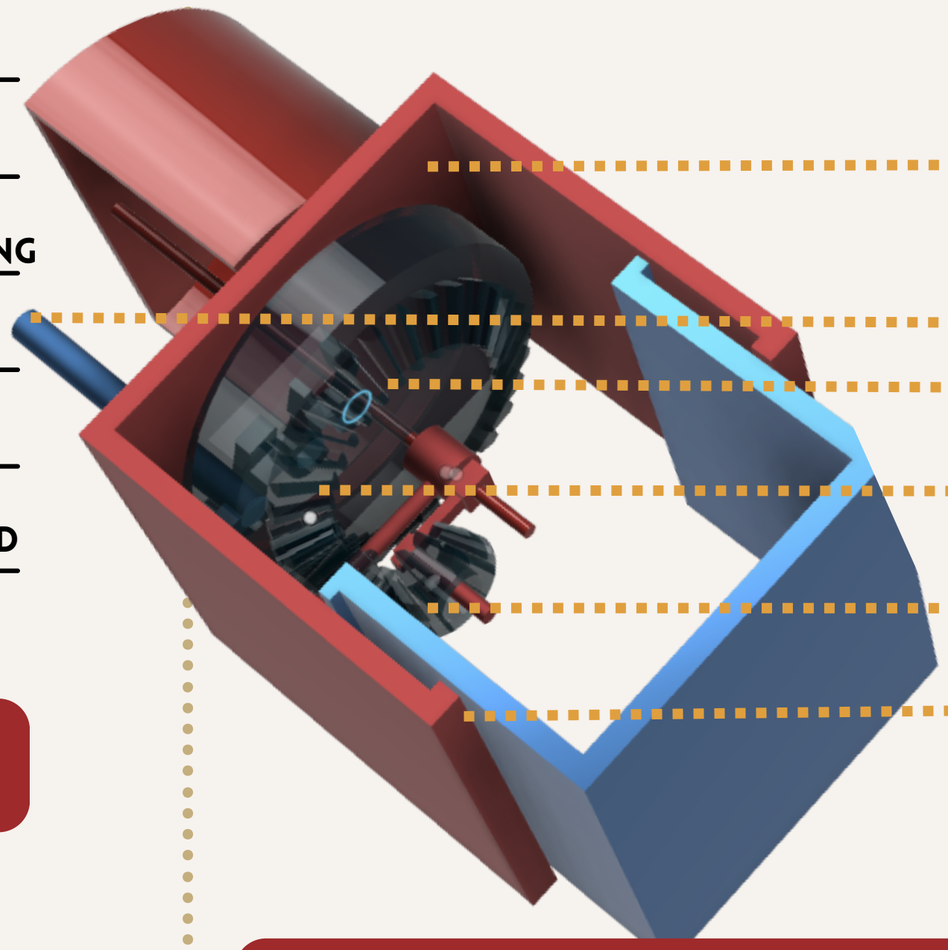
How Does Osteoarthritis Affect Cordage Making?

01 Limits capability for fine-motor motion
02 Limits capability for repetitive motion
03 Limits grip-strength
04 Extensive force on joints can cause pain
05 Repetitive motion can trigger Osteoarthritis attacks

Objectives

- ☑ SHOULD MINIMIZE FORCE ON THUMB JOINTS
- ☑ SHOULD MINIMIZE REPETITIVE MOVEMENTS
- ☑ SHOULD REDUCE FINE-MOTOR MOVEMENTS
- ☑ TO INCREASE THE SPEED OF CORDAGE MAKING
- ☑ SHOULD BE NOT FULLY AUTOMATED
- ☑ SHOULD BE INTUITIVE TO USE
- ☑ ACCOMMODATES VARYING LENGTHS OF REED

Our Current Solution



External Case

Ergonomic Handle

Large gear to twine second piece of reed with the first

Three 90° Bevel Gears create an interactive gear system

Small gear to twist the first piece of reed on its own axis

Adjustable wall end to accommodate varying reed lengths

Design Process

Framing
Through evaluating stakeholders' most urgent needs, the team decided to rescope on cordage making process.

Diverging
Through Lotus Blossom, Brainwriting 6-3-5, and Scamper, the team diverges 8 distinct potential designs.

Ranking Requirements
Through evaluating Stakeholders' requirements and impacts on osteoarthritis patient, the team ranks the requirements.

Iterating
Through the ranked requirements, the designs are elaborated according to the requirements.

Converging
Through Pugh Chart and Pair-Wise Comparison, the team selected Gearhub Cordage Compiler as the final design.

Key Design Decisions

01 Transforming the twisting motion of cordage-making into a motion that mirrors a beneficial exercise for people with Osteoarthristis

Handle-Turning Motion Mirrors the Following Exercises:

O-shape

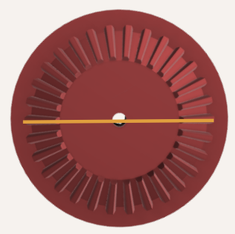
Grip-Stengthener

02 Increasing the speed of the process

03 Minimize the force required to turn the handle

Leveraging the difference in circumference between the biggest and smallest gear to produce multiple rotations of the smaller gear with a single rotation of the larger gear. Increased the rotational efficiency by 84%.

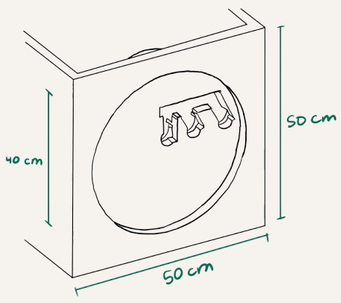
20.7cm



10.7cm

Larger gear ratio also minimizes the force required to turn the handle

04 Incorporate Adjustability



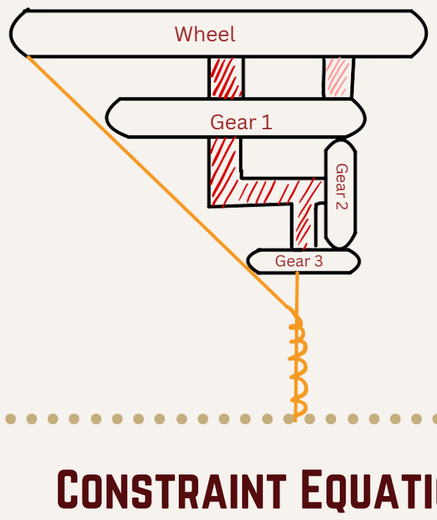
By making the handle adjustable, the user is able the change the amount of force they must apply to turn the handle, by increasing or decreasing the radius of rotation

SUSTAINABILITY DEVELOPMENT GOALS

According to the United Nations Sustainable Development Goals, We want to prioritize:

Responsible Consumption and Production

We will do this by **minimizing the amount of cordage that will be wasted when using this device**



In order to do this, the ratio between the wheel and Gear 1 and Gear 1 and Gear 3 must be maximized. However, we must keep the consider that the ratio between Gear 1 and Gear 3 isn't too big, as the torque applied on the reed would not be enough to turn it.

We must find out the maximum ratio we could have between the diameters of wheel and Gear 1, and Gear 1 and Gear 2 by calculating the maximum torque needed to turn the string

Constraint Equation (Using the Torque Calculations)

$$8999z^2 - xz - 1.3yz - 2.3xy + 2.3y^2 = 0$$

x is the length of the wheel
y is the length of Gear 1
z is the length of Gear 3

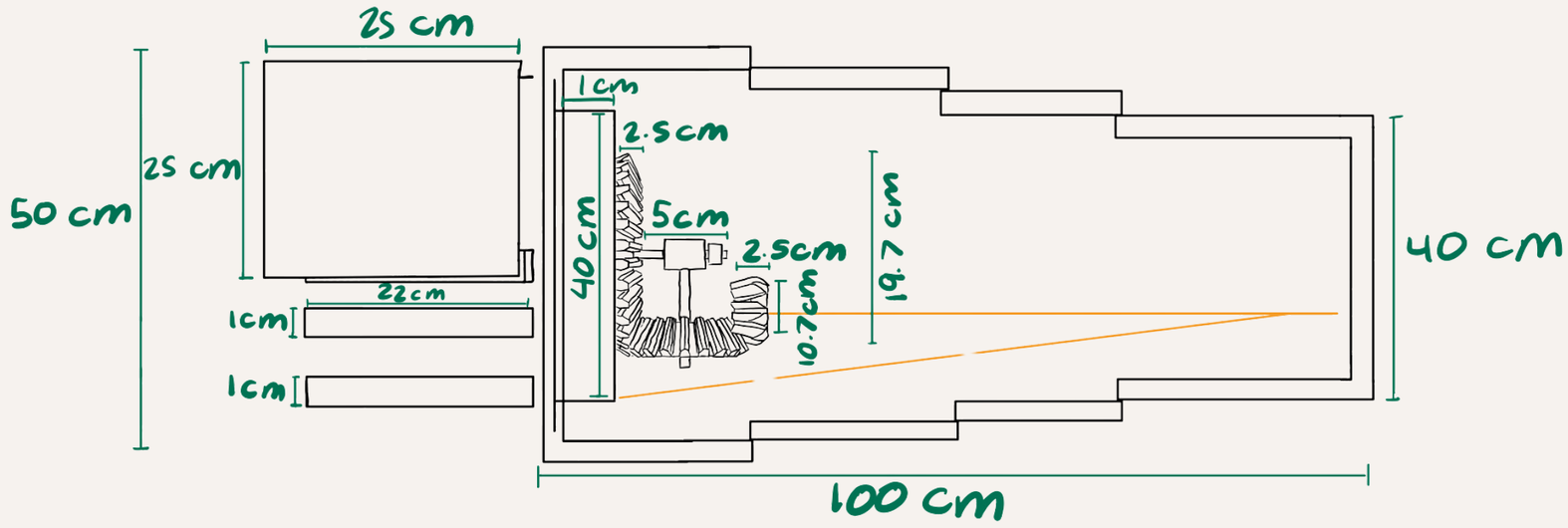
Objective Function (Ratios We Want To Maximize)

$$F(x, y, z) = 0.5\frac{x}{y} + 0.5\frac{y}{z}$$

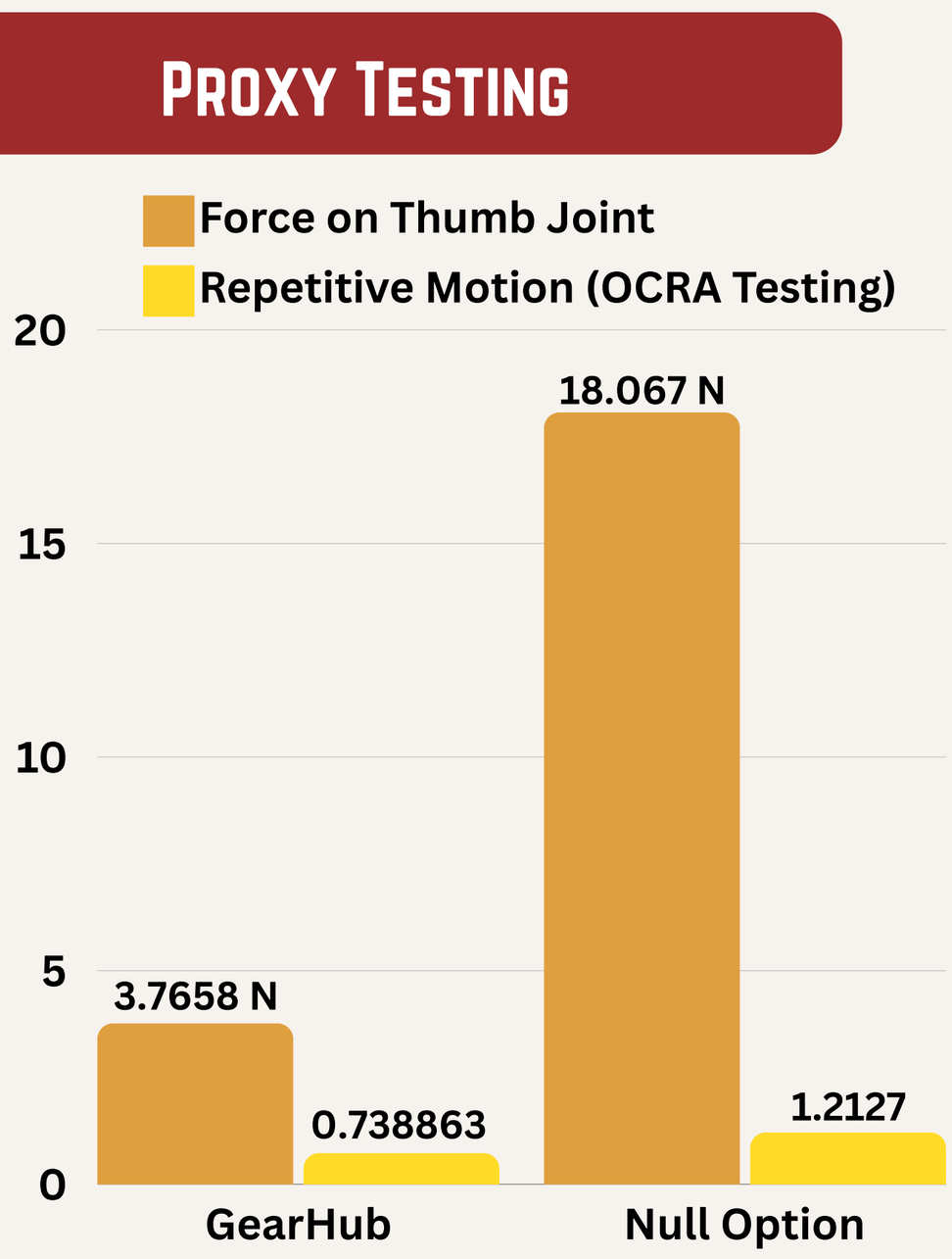
Using Machine Learning and Multi-Variable Calculus to Find the Optimal Gear Values

We found the the optimal ratio of
Wheel Diameter : Gear 1 Diameter : Gear 2 Diameter is
1.01 : 0.497 : 0.269

Using these measurements, we created a blueprint for our refined design



Proxy Testing



Future Steps

01 "Gamification" of the process

- Handle-turning motion of the cordage-making process still contains repetitive motion.
- A future advancement would be "gamification" of the turning mechanism, which would enable different motions and grips

02 Ease of Storage

- GearHub takes up a lot of space when compared to the null option
- We could have multiple layers of movable walls instead of just two, and the parts could be detachable.

03 Testing the Device for the Actual Use Case

- None of the members of our team have Osteoarthritis, and thus, there may have been some considerations that we neglected in our testing process