

Combat Food Insecurity

Children of the Corn



Background



Stalk Lodging

Definition:

Breakage of the stalk below the ear



Costs

Annual loss in U.S. of 5%-25%

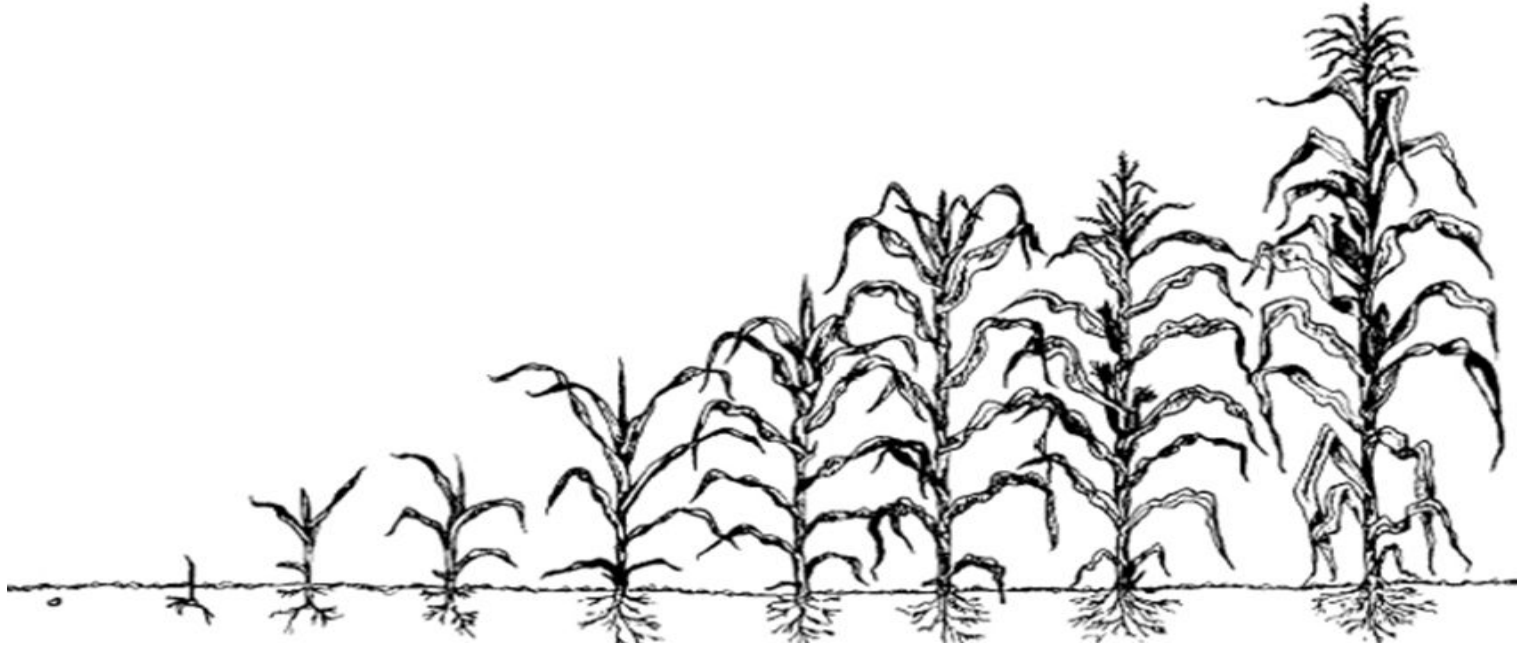
Increased harvest time

Increased drying costs

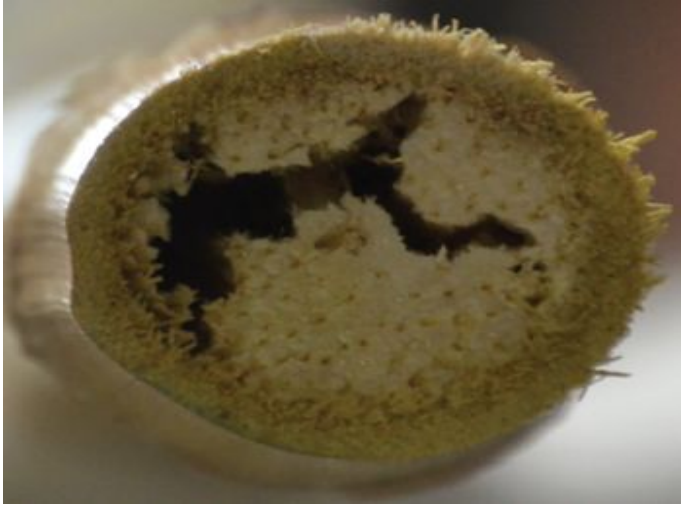
May cause volunteer corn



Structure of Corn



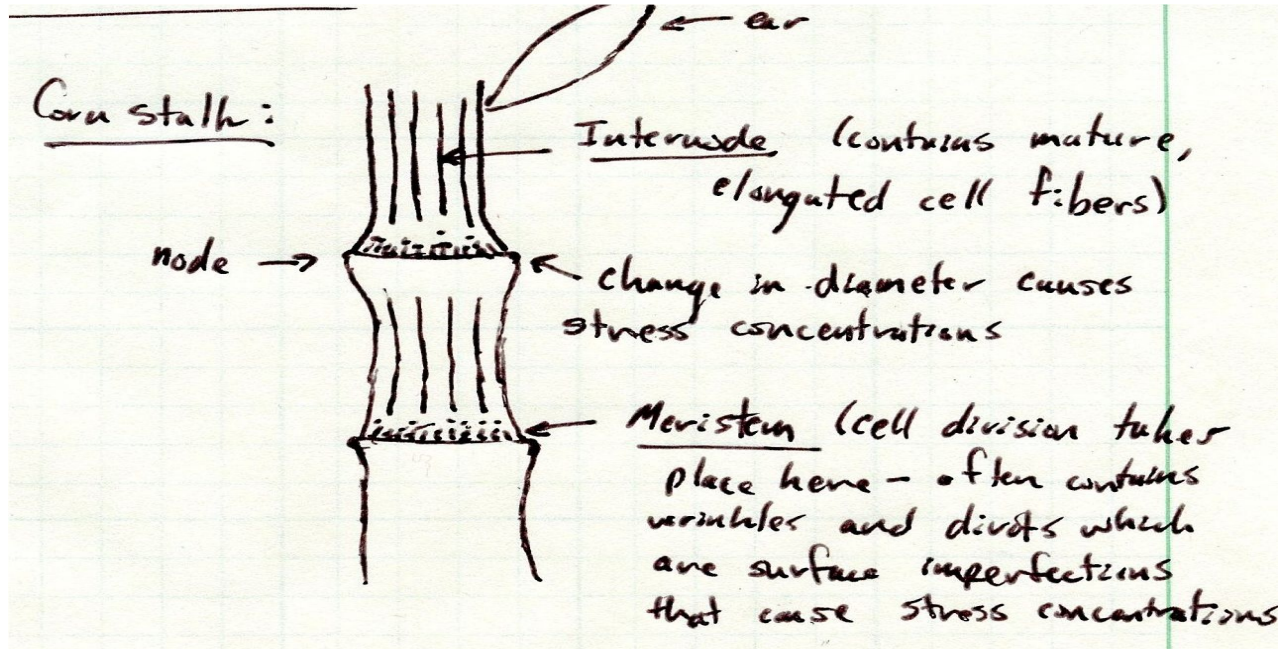
Structure of Corn



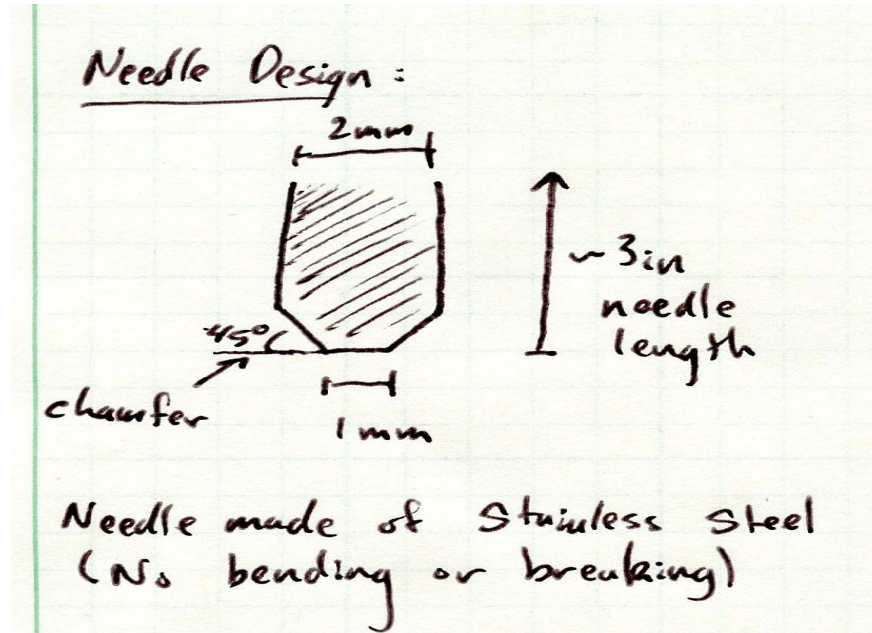
Research



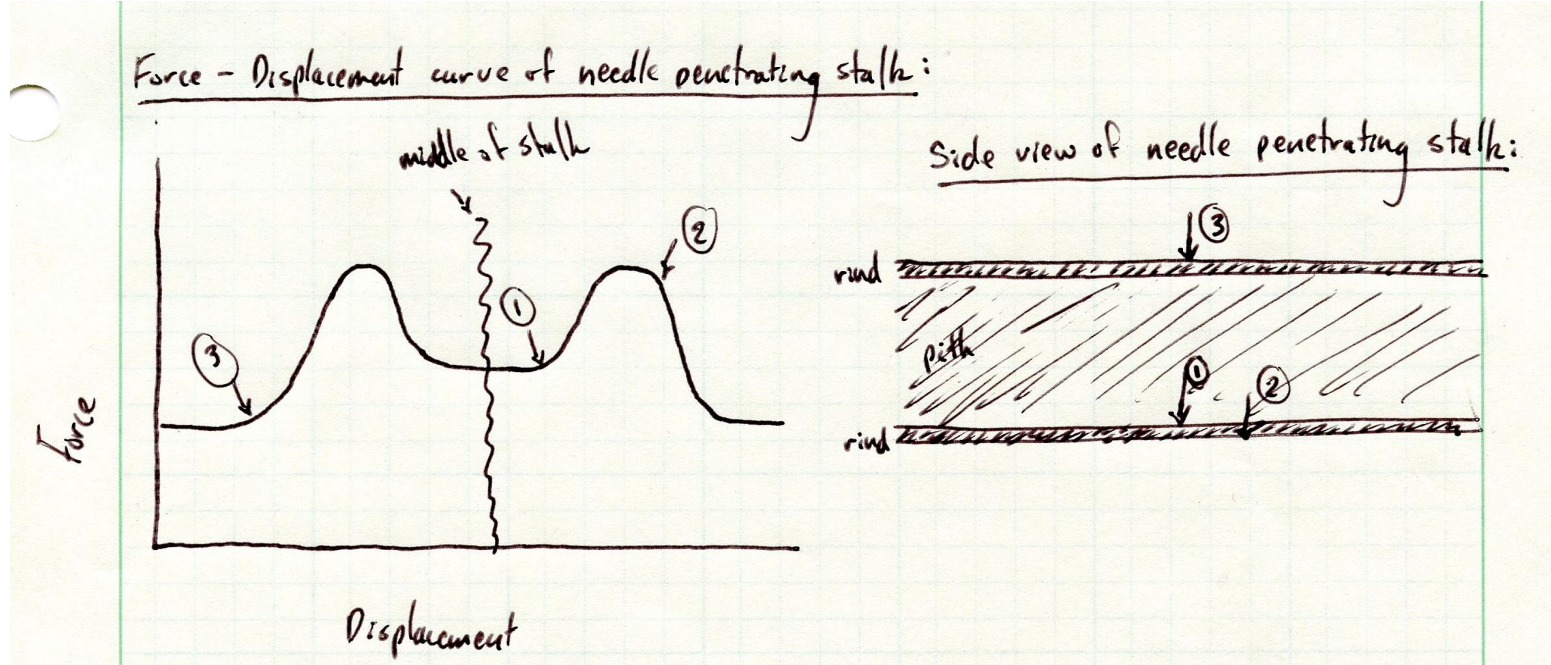
Structural Weaknesses



Needle Design



Concept



Specifications and Constraints



Constraint/Specification

Item must be easily portable, lightweight, force required to operate must be reasonably low.

Item must be handheld, operable by one person.

Item must be durable. Must withstand drop of 10 ft., be impervious to dust, water, hazardous conditions.

Device must measure distance with accuracy of +/- 0.01 mm, measure a total distance of 3-4 inches, collect at a rate of at least 20 Hz, preferably 50 or higher.

Must use existing User Interface.

Reason

Item will be operated for eight continuous hours at a time, goal is to not tire out user.

Inconvenient if device needs two people to operate.

Item may be operated in environments considered rough on electronics.

This is an error of roughly 1%, considering that stalk rinds tend to be about 1mm thick. This distance is the expected distance the needle will move in total. Data collection rate is related to need for high accuracy.

Those testing the device will be familiar with existing UI.



Constraint/Specification

Must use existing needle design.

Design must include backplate, with small hole for needle. Hole cannot be much larger than needle.

Device must include data logging.

Device must measure force required to push needle through stalk.

Project should search for mostly “off the shelf” parts.

Reason

This needle has been found to produce most consistent results.

Back of stalk needs to be supported to receive consistent results. Hole is to prevent fatigue or fracture of needle. Hole size is to prevent the stalk deflecting through a large hole and giving a bad result.

Data will be analyzed later to phenotype strength of different maize varieties.

Needed for data analysis of force vs. displacement.

Parts need to be easily replaceable, inexpensive to create a mass quantity of the device (less manufacturing necessary, the better)



Components



Load Cell

S Load Cell



Pancake Load Cell



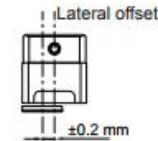
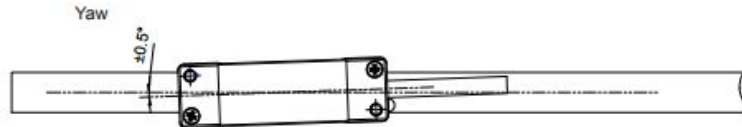
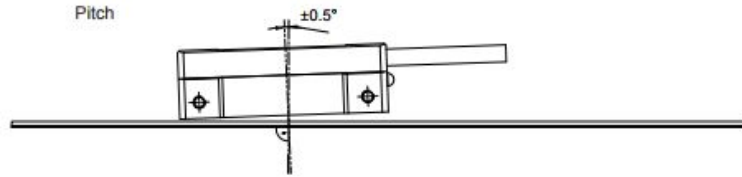
In-Line Rod Load Cell



Linear Encoder

Rotary and Linear Absolute and Incremental

Installation tolerances



Actuator

4" stroke

35lb rated load

1.65"/sec average

Linear feedback included

12VDC

2A draw at max load



Electronics

Pololu 1378 Motor Controller

Arduino Uno / Mini Pro

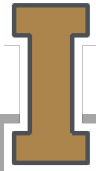
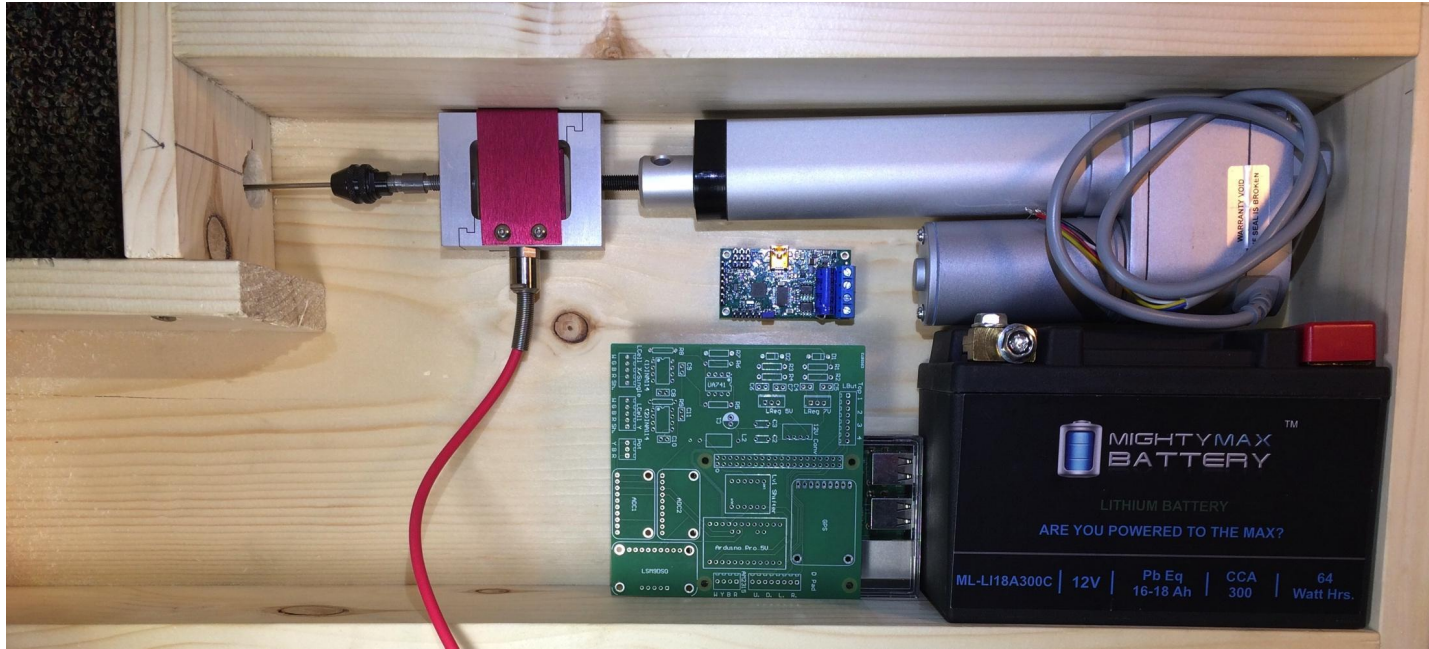
Raspberry Pi 3b



Viable Designs



Actuator-Driven Design



Actuator-Driven Design

Pros

Constant speed and force
On-board position feedback
Button-operated

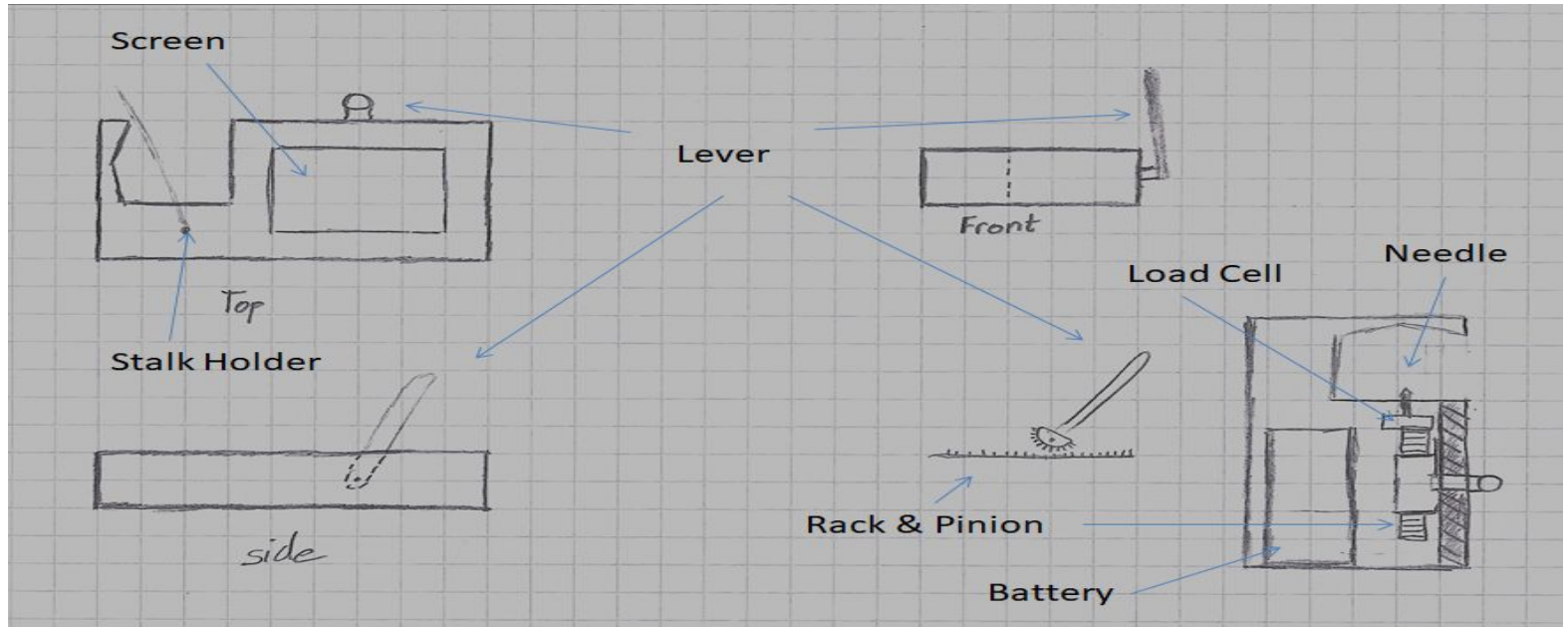
Estimated Cost: \$1000

Cons

Heavy (10-15lb)
Unwieldy Case (22" x 8" x 4")
Difficult to hold case and use
screen simultaneously



Hand-Powered Design



Hand-Powered Design

Pros

Lightweight

Small

Simple to operate

Estimated Cost: \$900

Cons

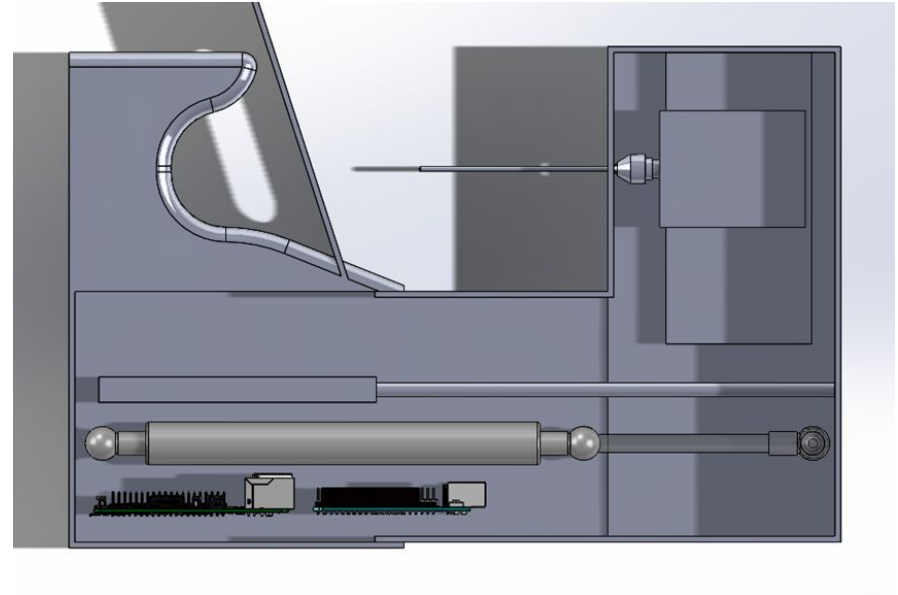
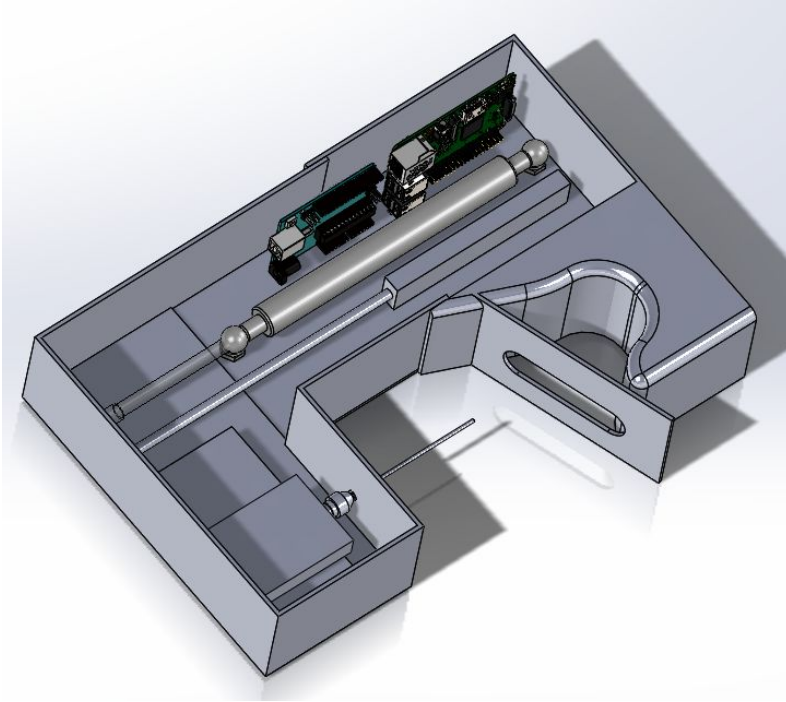
Two hands to operate

Poor consistency of force

Tiring to do ~800 times a day



Gas Spring Design



Gas Spring Design

Pros

Lightweight and small
Constant, adjustable rate
and force
Able to be controlled with
switches or triggers

Cons

Case will require customizing
Case sliding together could be
weak or difficult to make
Needle is always exposed

Estimated Cost: \$1100



Timeline For Project Completion



Overview

Fall Semester

Working prototype
Actuator-operated

Spring Semester

Refined, marketable product
Manually operated



Mechanics

Fall Semester

Needle (10/20/17)

Barebones case (11/1/17)

Back plate (11/15/17)

Mount actuator (11/29/17)

Mount load cell (11/29/17)

Spring Semester

Off-the-shelf case, cutouts (TBD)

Develop manual operation (TBD)



Electronics

Fall Semester

Voltage regulator (10/20/17)

Load cell (10/30/17)

Linear feedback (10/30/17)

User-friendly actuator operation (11/10/17)

GUI (11/29/17)

Data logging (11/29/17)



Electronics

Spring Semester

Implement updated GUI features (TBD)

Find sample frequency bottleneck (TBD)

Refine algorithms (TBD)

Update PCB (TBD)



Potential Risks and Problems

Data cannot be collected accurately and precisely
Unable to attain user-friendly design
Attaching components to case securely



Questions?

