CO_2 Powered Staple Gun

Showcase

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Project Definition and Objectives

Project Definition

- Adapt a typical Pneumatic Staple Gun to accept CO_2 and Romex Staples

Objectives

- Find the required pressure range to drive a staple into a typical Stud
- Determine the viability of using CO_2 as a propellant for the gun
- Adapt a purchased staple gun to accept both the staples and the gas

Project Challenges

Usage of CO2

- Advantages of $C0_2$ include:
  - Small compact fuel source, no need for an air compressor
  - Stand alone fuel source, no need for a charger or an outlet
  - Widely available for purchase
- Disadvantages of CO_2 include:
  - Dependence on temperature
  - Increased wear due to higher pressure
  - Higher pressure could lead to damaged Romex Cables
  - Limited shots depending on capacity of CO_2 cartridge

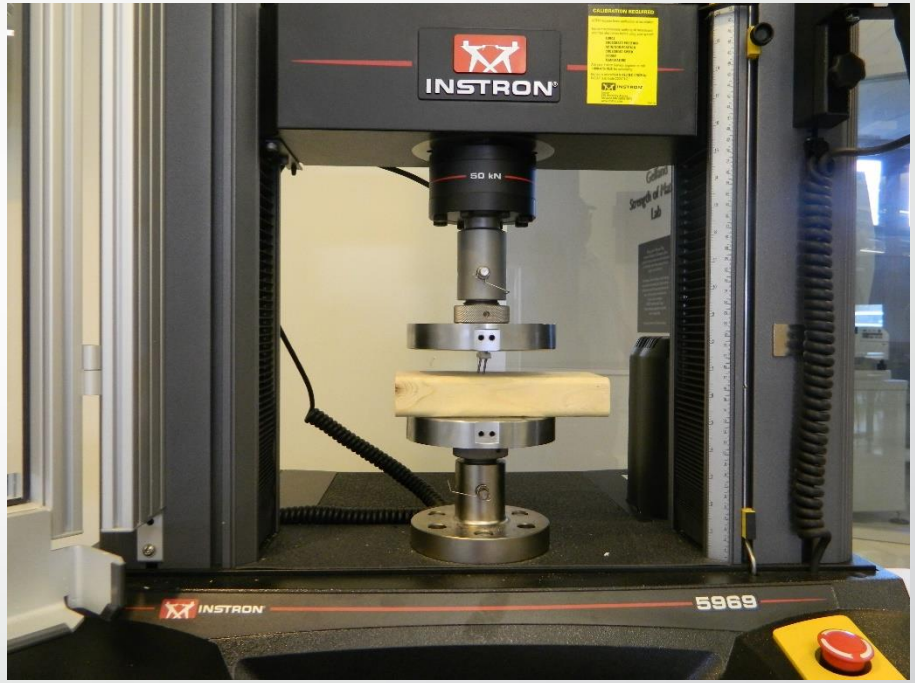
Loading Mechanism

- No such device exists for these particular staples
- Firing mechanism must be modified to accept this loader
  - A modified Hammer should suffice

Methods and Testing

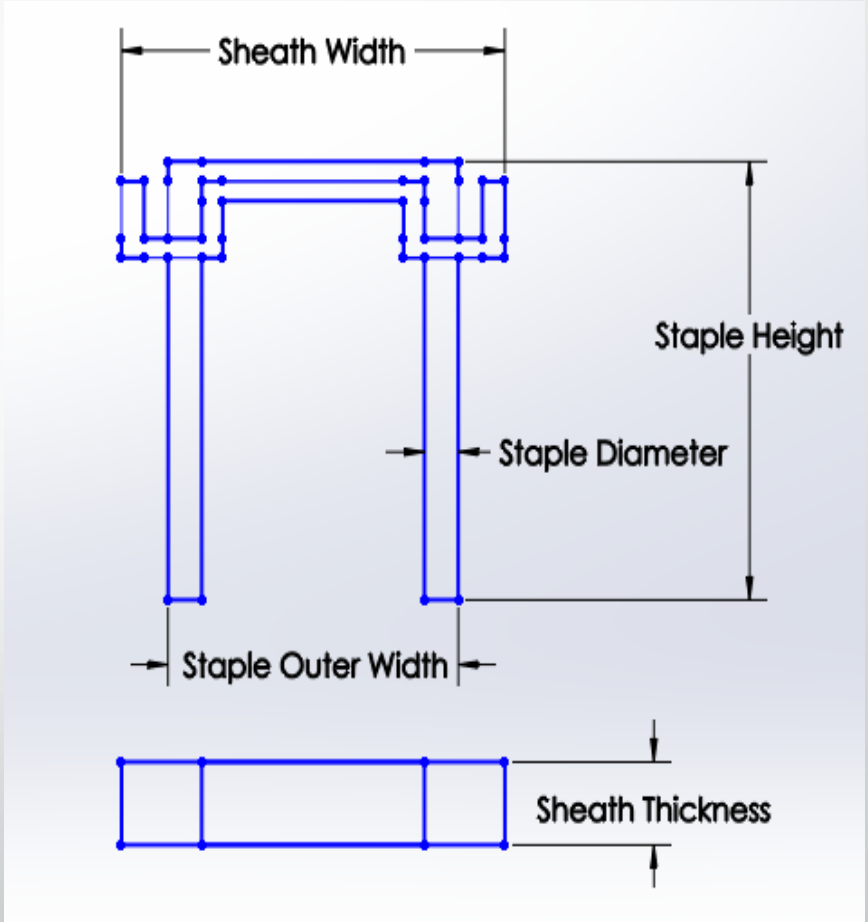
4 Main Tests

- Insulated Staple Measurements
  - 120 staples from 2 different brands
  - Measured to determine manufacturing variance
- Shot Volume Test
  - Using a balloon, the volume for each shot was determined
  - Fired at a variety of different pressures, with Air and CO_2
- Drive Depth
  - Measured drive depth of brad nails and finishing staples
  - Fired at a variety of different pressures, with Air and CO_2
- Instron Compression Test
  - 60 staples from 2 different brands
  - Determined the average amount of energy to drive insulated staple into stud



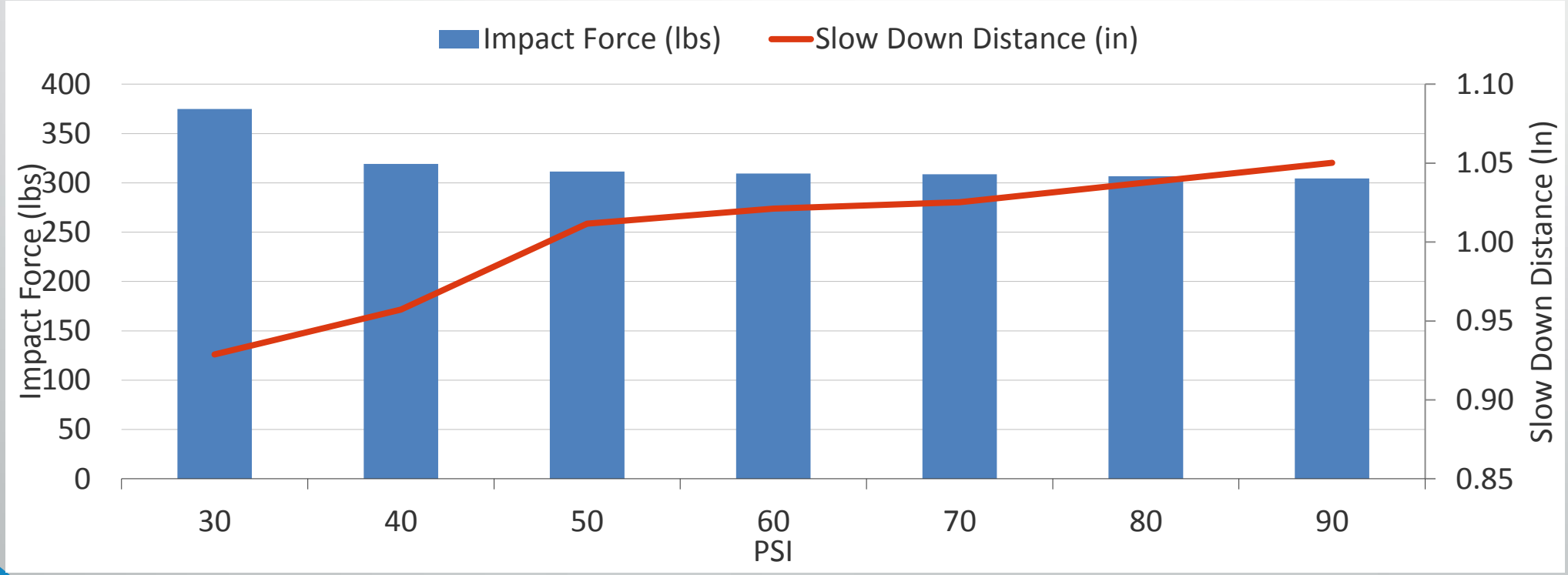
Insulated Staple Measurement Analysis

- Measured staple variability to ensure proper loading mechanism tolerances
- Two critical dimensions:
  - Sheath Thickness
  - Sheath Width
- Redesigned loading mechanism
  - New critical dimension: staple diameter



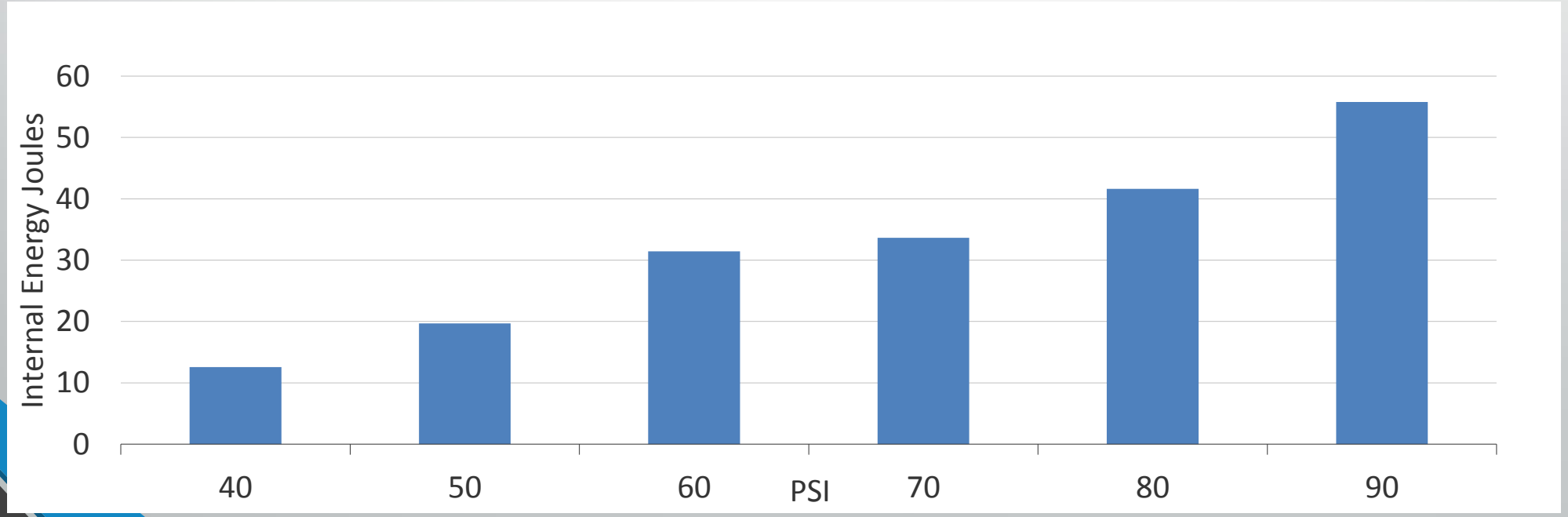
Drive Depth Impact Force Test

- Drive 5 staples into stud at varying pressures of interval 10 (30,40,50 psi)
- Measure the drive depth to determine the slowdown distance
- Solve for the impact force using drive distance



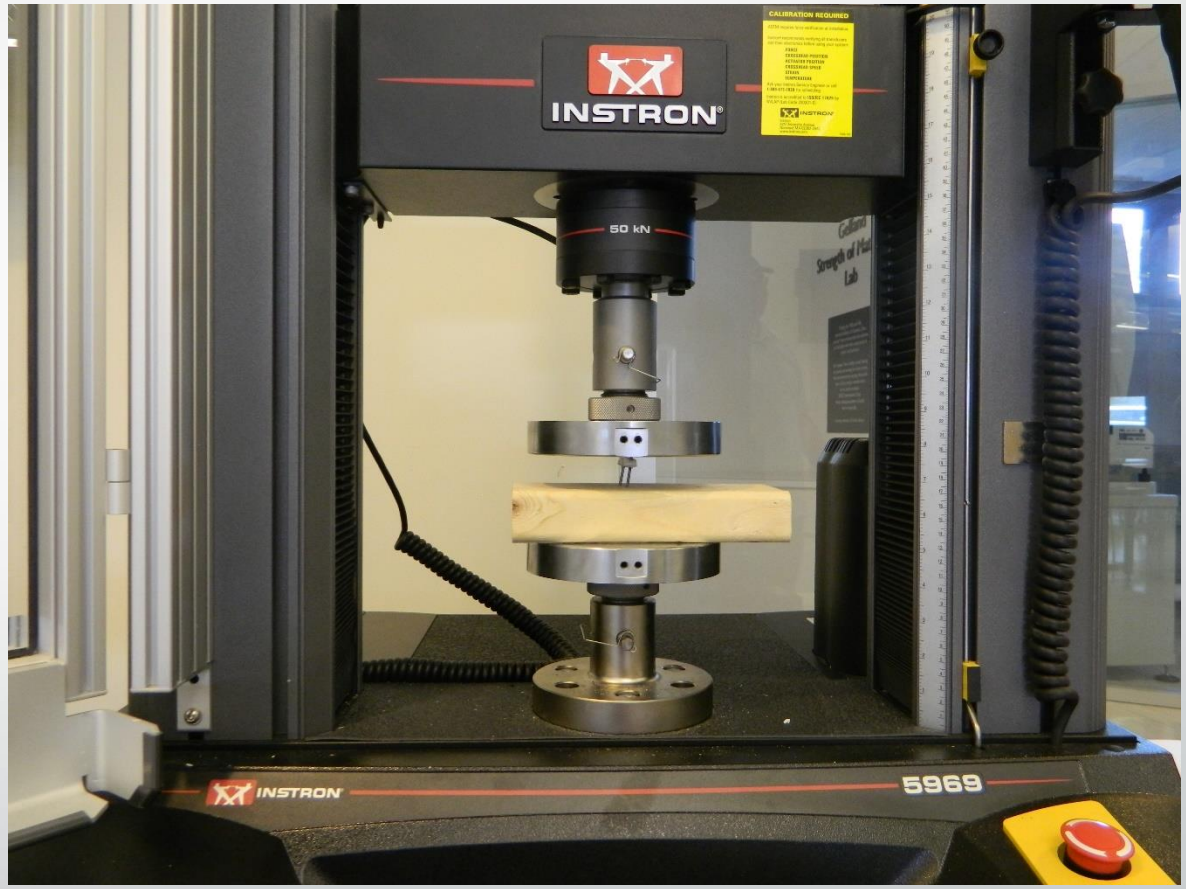
Shot Volume Test

- Gun was loaded with CO_2
- Adapter was attached to exhaust to capture the gas
- Tested in two ways
  - Shots to a specific volume
  - Volume from a specific amount of shots
- Solved for available energy per shot using results

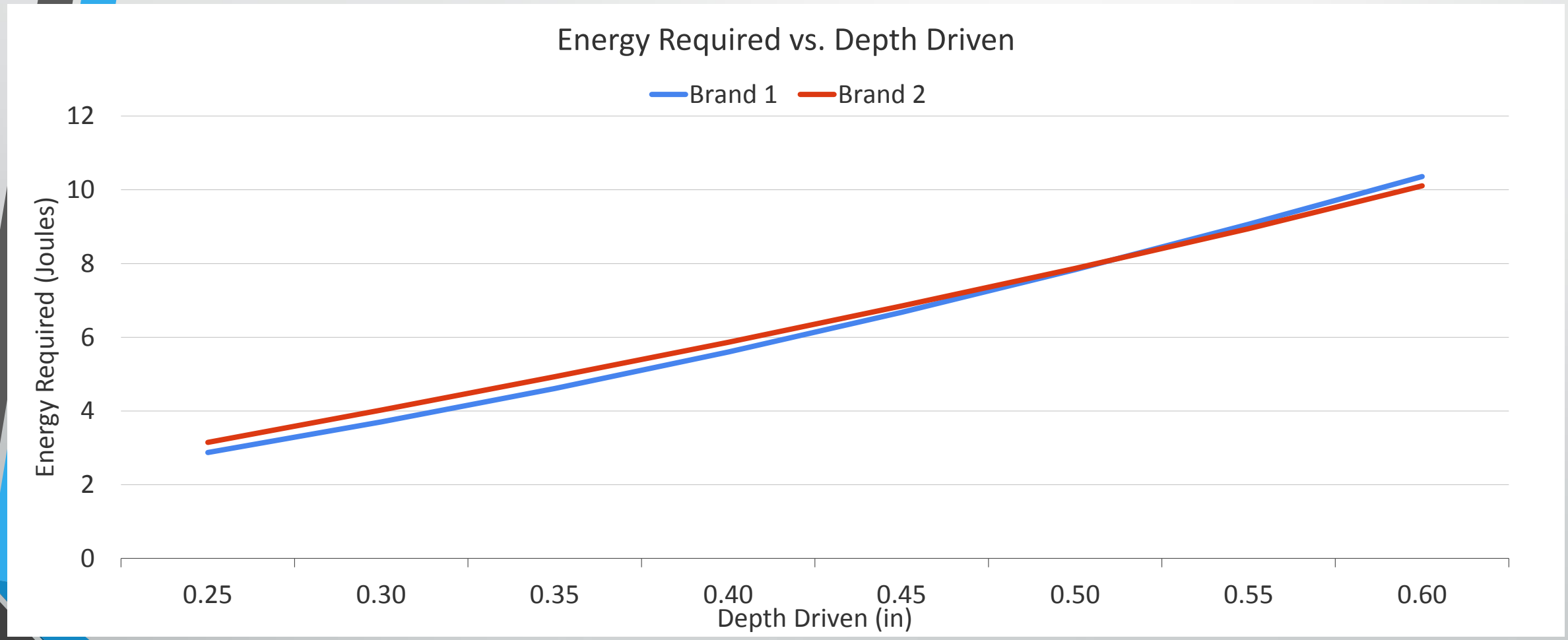


Instron Compression Testing

- Used an Instron Compression Testing Machine
- Stud was cut down to size and an ICS is fitted onto the wood
- Staple was driven down a specific depth to measure energy
  - This depth is the typical drive depth for a ICS including a Romex Cable
- Using the raw data, average energy for drive was found

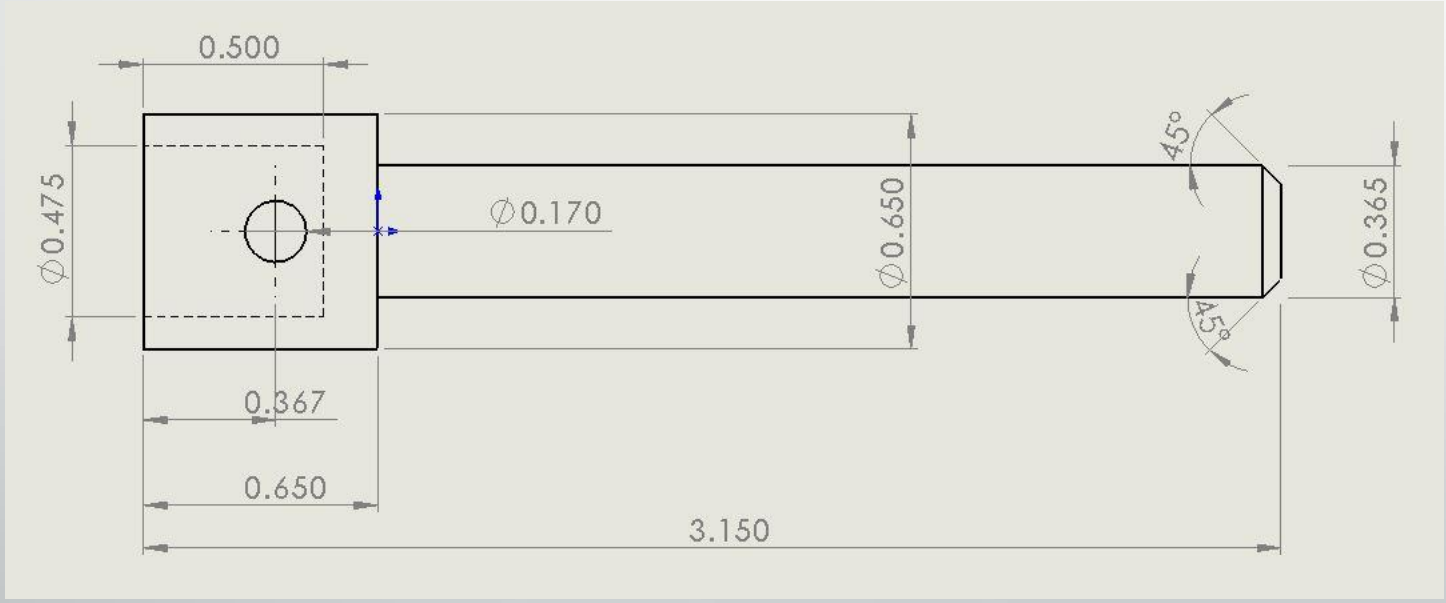


Instron Testing Results



Striker Piston

- Designed to fit as a cap over the old striker piston
- Machined out of round aluminum stock with a lathe
- Cut to length and chamfer to account for deformation of aluminum



Staple Driving Mechanism

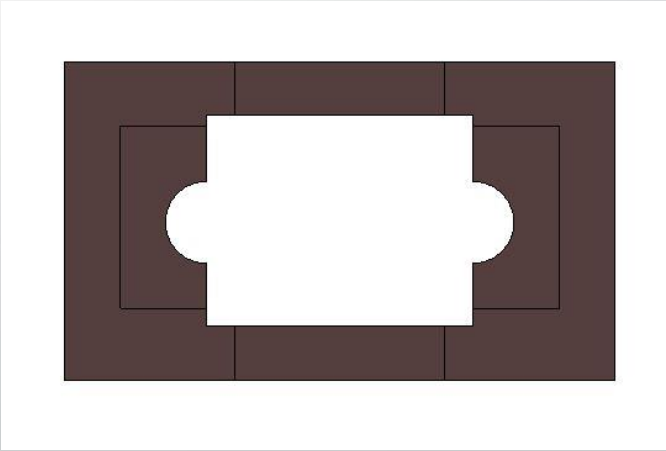
- 2 parts: Base Plate Mount and the Magazine
- 2 designs: Radial and Vertical Stacked

Base Plate Mount

- Attaches to the gun and is used to hold the magazine in place during firing
- Uses original magazine attachment point
- Present in both designs with minor modifications

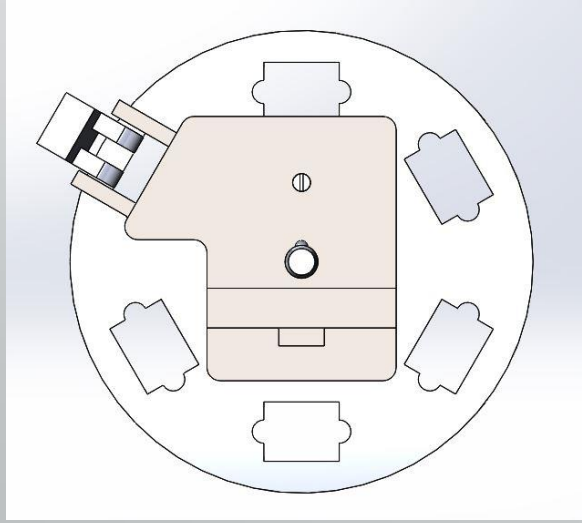
Magazine

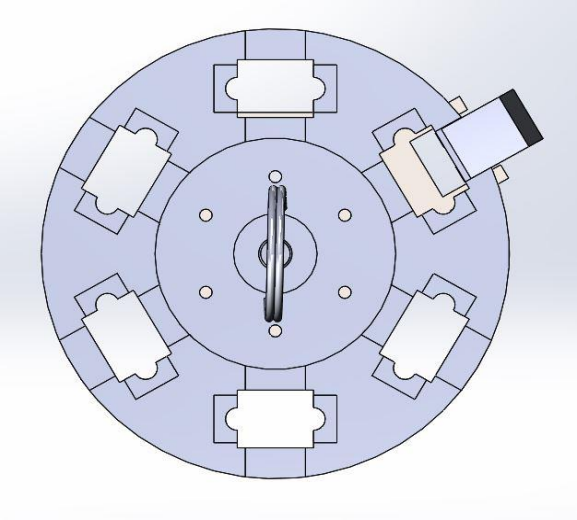
- Each Magazine uses the same style holder to grip the staple
- Helps to guide the staple down to cable height
- Holds cable in place during firing
- Attached to the base plate
  - Radial uses a quick release pull pin
  - Vertical Stacked uses a guided rail

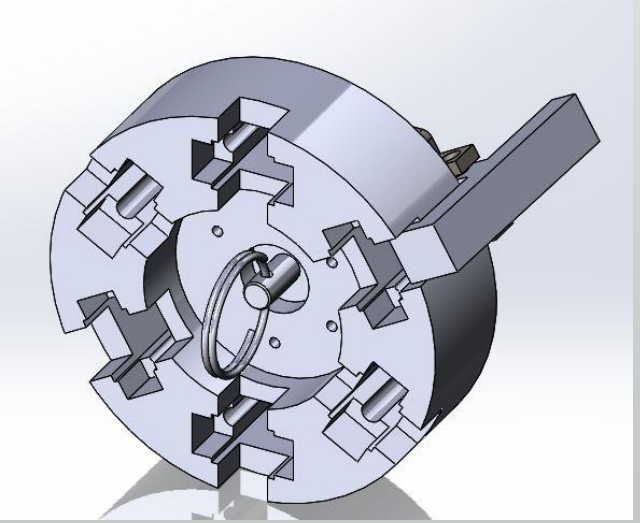


Radial Staple Driver Overview

- Revolving magazine holds 6 staples
- Two designs for locking the magazine into place: key mechanism and ball detent mechanism
  - Key mechanism: The key pivots around a screw on the base plate and is held down with a radial spring. The end of the key fits into slots on the magazine to prevent the magazine from rotating
  - Ball detent mechanism: A ball detent plunger screws into the base plate. The ball fits into holes on the magazine to prevent magazine rotation
- A pin with a ball detent holds the magazine to the base plate and serves as the axis of rotation

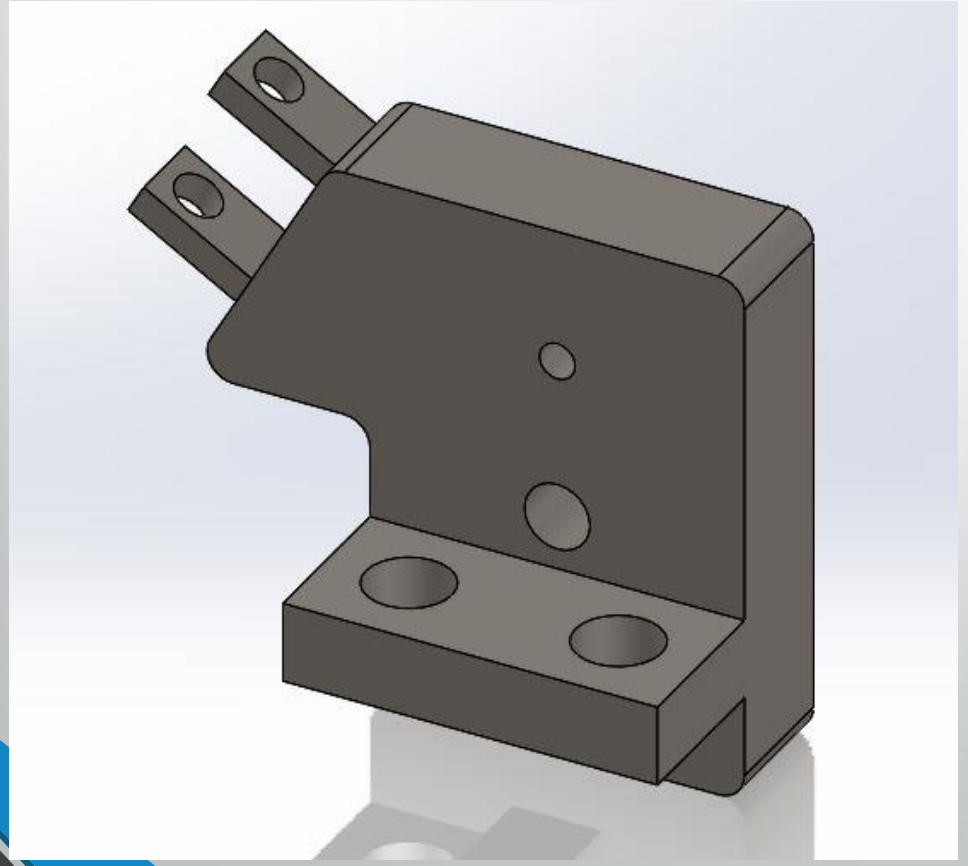


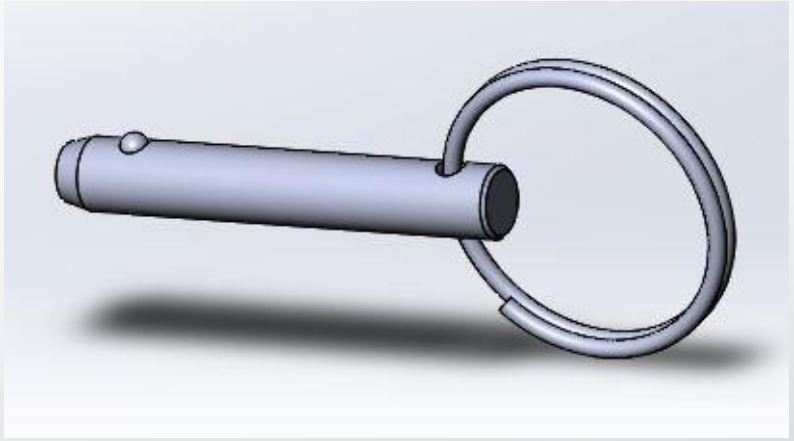


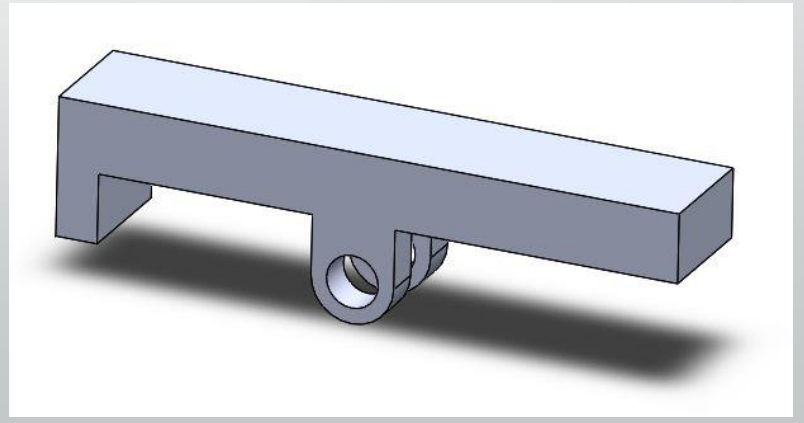


Radial Base Plate and Key Design

- Holds magazine to the staple gun
- Key locks magazine to prevent it from spinning between shots
- A torsional spring will be used to keep the key in place

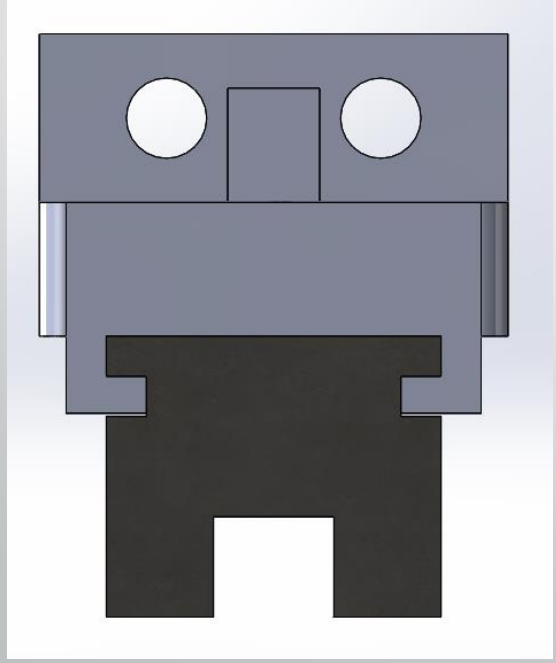


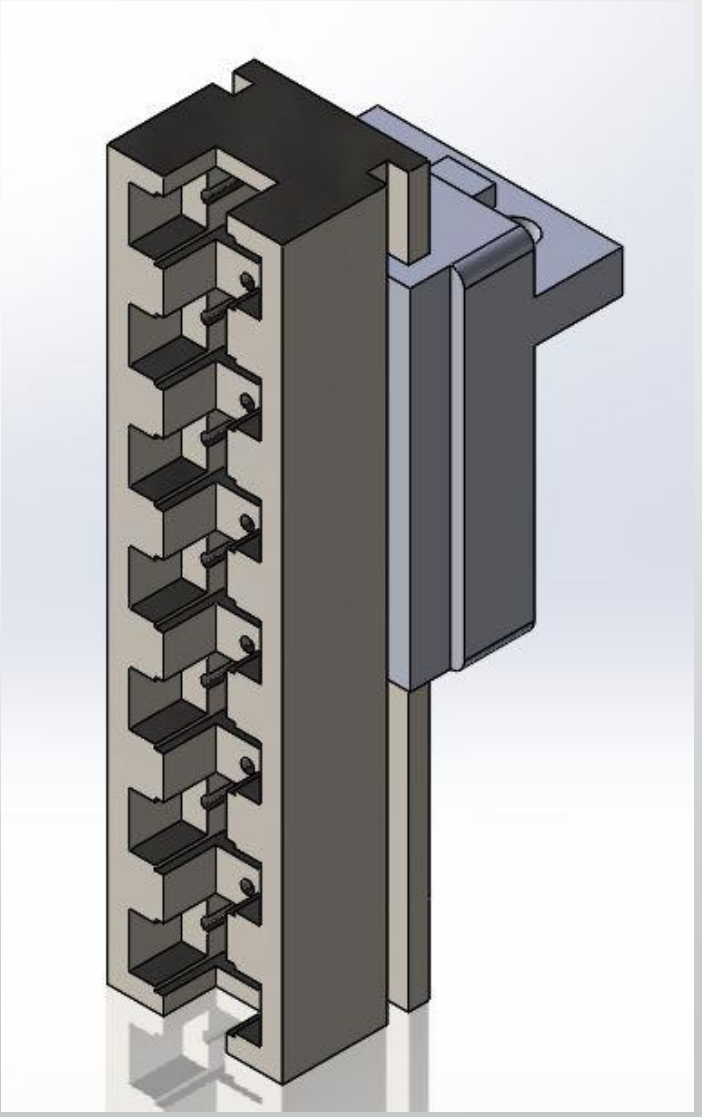




Vertical Stacked Driver Overview

- Designed as a counterpart to the radial mechanism
  - Fits in tighter spaces than the radial mechanism
  - Holds more shots
- Slight modification to original base plate
- Redesigned vertical magazine





Radial Driving Mechanism

- Current prototype is a little insecure due to the tolerances of the 3D printed parts
- The rails help the staple fire into the wood without buckling
- There is not enough force holding the base and radial mechanism together for the ball detent to function properly
  - This could be solved by adding washers onto the pin or using a shorter pin

Conclusions

- Future designs should be made with more precise tolerances to prevent wobbling
- Base plate should be redesigned to include a bearing for better rotation
- Final design will only have the ball detent locking mechanism and not the key design

Vertical Stacked Driving Mechanism

- Able to grip cable while firing
- Staples are driven straight using the rails
- Magazine is completely reversible
- Magazine held in place securely requiring manual input to cycle in a round

Conclusions

- No significant performance increases from the radial mechanism
- Has the potential for a higher capacity magazine
- Can fit in tighter spaces than the radial mechanism
- Easier to work and maneuver

Project Future

- Due to the limited time, only a modification was feasible
- Most parts were created with 3D Rapid Prototyping

Recommendations

- Develop a completely original staple gun with components designed specifically for CO_2
- Have an internal regulation system for controlling pressure
- Internalize the CO2 cartridge
- Machined parts for withstanding fatigue and extending tool life
- Automatic loading mechanism to allow the staple to be fed by the gun