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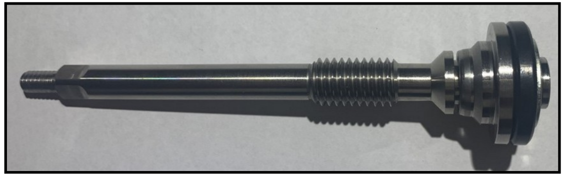
# Automated Handvalve Assembly: Final Review

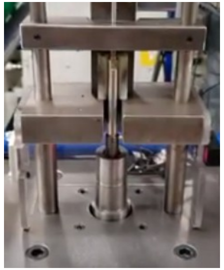
By: Ahmed Khalil, Erik Svetin, Hannah Fibikar, and Megan Sindelar

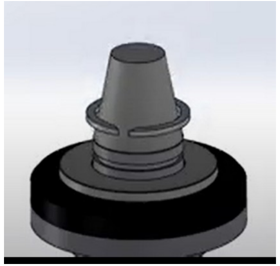
# Presentation Outline

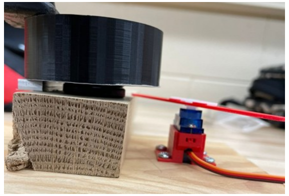
Background

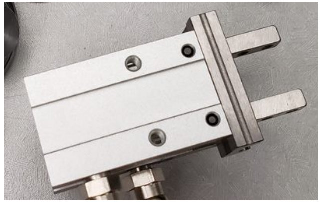


Proposed Solution









Future Steps

Parker [1]

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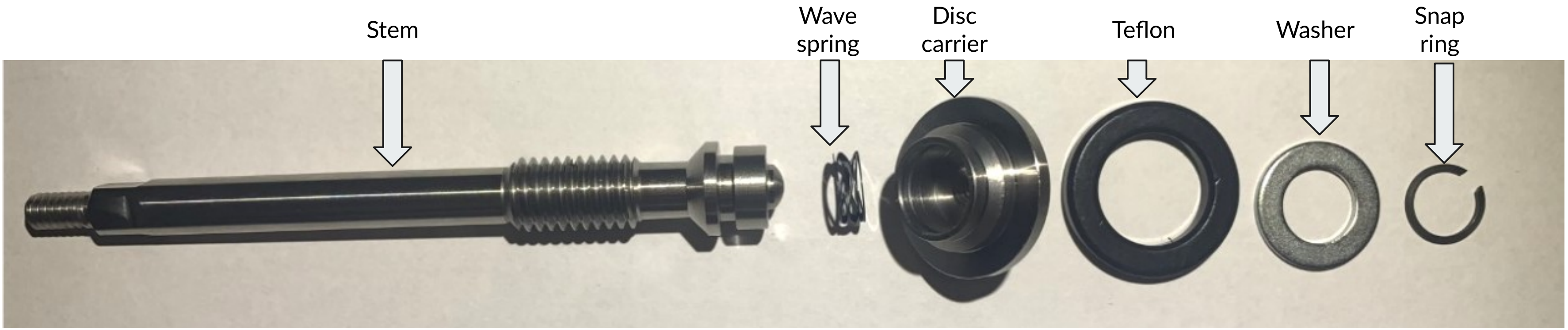
# Currently, Parker employees assemble up to 312 handvalve stems each day by hand

Looking to fully automate it

- Client needs:
  - Cost
  - Performance
  - Safety
  - Self reliance
  - Footprint

# There are 6 main components required for assembly

Components:

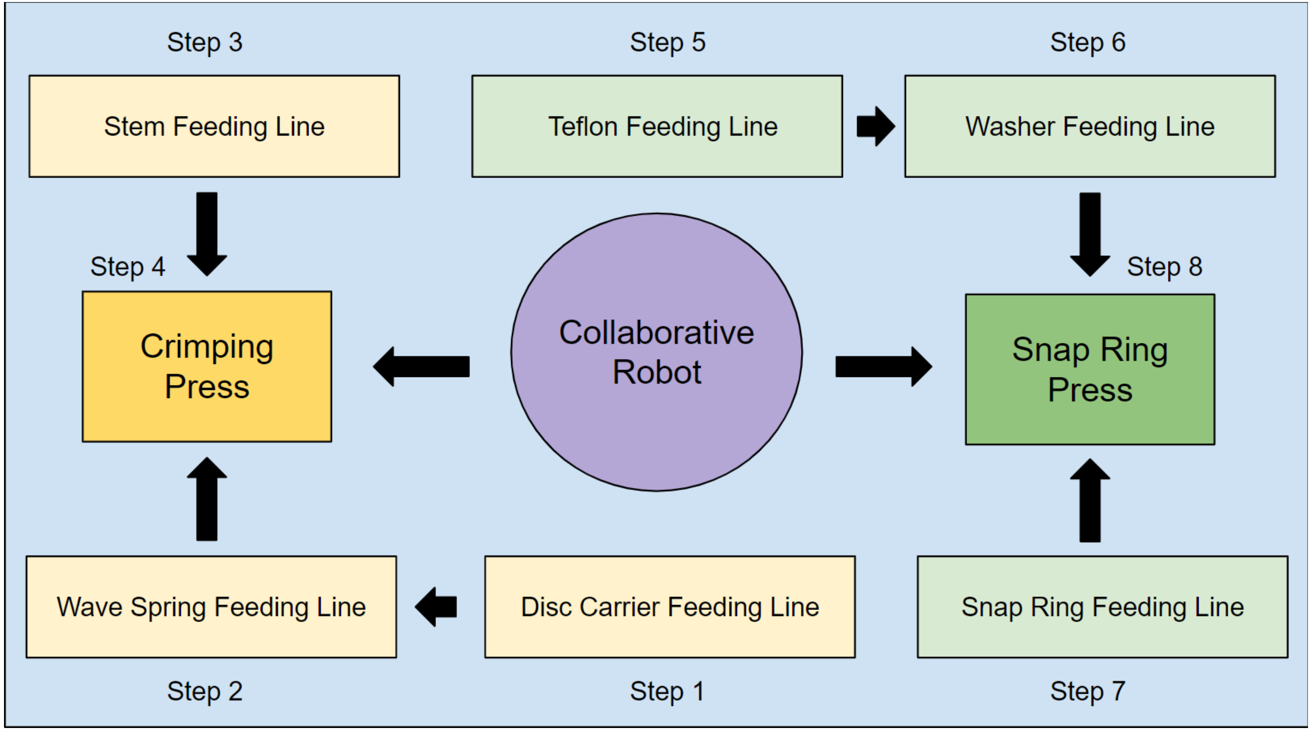


# This assembly is composed of five main steps

1. Wave Spring into Disc carrier
2. Stem into Wave Spring
3. Crimp Wave Spring
4. Teflon and Washer onto Disc Carrier
5. Snap Ring onto Disc Carrier

# Proposed Solution

# The automated process can be efficient and compact




15x15 ft area

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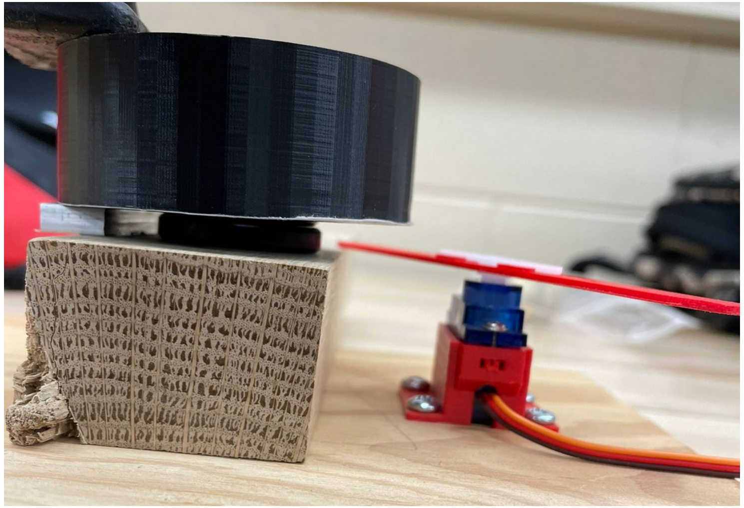
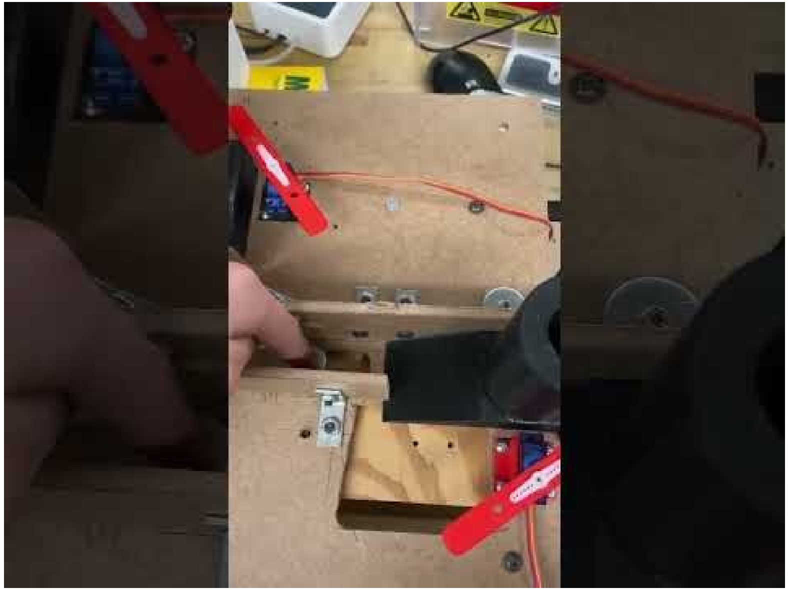
# Feeding System

# The current feeding system could be used for any part with a uniform cross-section



# Parts will be separated using continuous servo motors



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# Proposed feeding system's pros and cons

Pros of feeding system:

- Easy to setup and troubleshoot
- Cheap to construct

Cons of feeding system:

- Asymmetric rotation makes the dynamics more complicated
- Prone to failure if servo motor is moved out of position
- Dependant on the size of the stack
- Does not eliminate any of the robot's tasks

# Future design iterations of feeding system

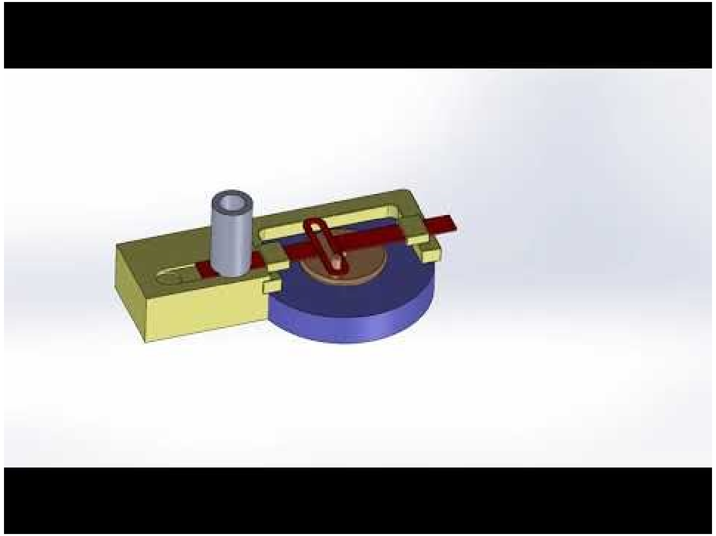
Rotary to linear mechanism

Pros:

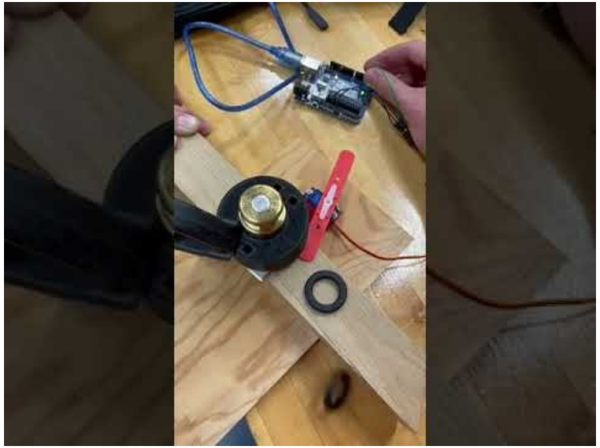
- Push part directly to negative mold
- Simpler design dynamics
- Less prone to variation from stack size
- More accurate and precise

Cons:

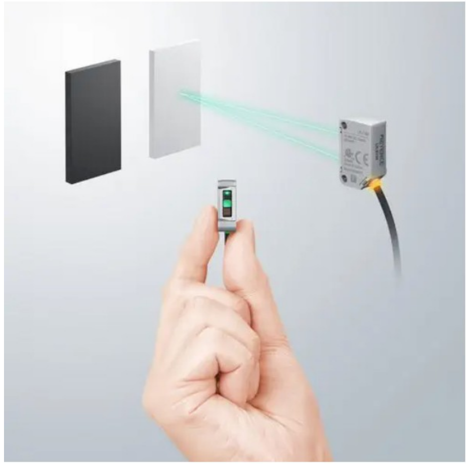
- Does not eliminate any of the robot's tasks
- More components increase chance of failure



# Actual design will require more robust components




[2]



[3]

# Robotic Arm

# Comparisons between the top three collaborative robot (cobot) options for this application


[4]


[5]


[6]

| Parameters | GoFa | Swifti | UR5e |
|---|---|---|---|
| **Payload [kg]** | 5 | 4 | 5 |
| **DOF** | 6 | 6 | 6 |
| **Reach [mm]** | 950 | 475 and 580 | 850 |
| **Max Speed [m/s]** | 2.2 | 5.05 | 1 |
| **Starting Cost** | $30,802.72 | $30,802.72 | $35,000 |

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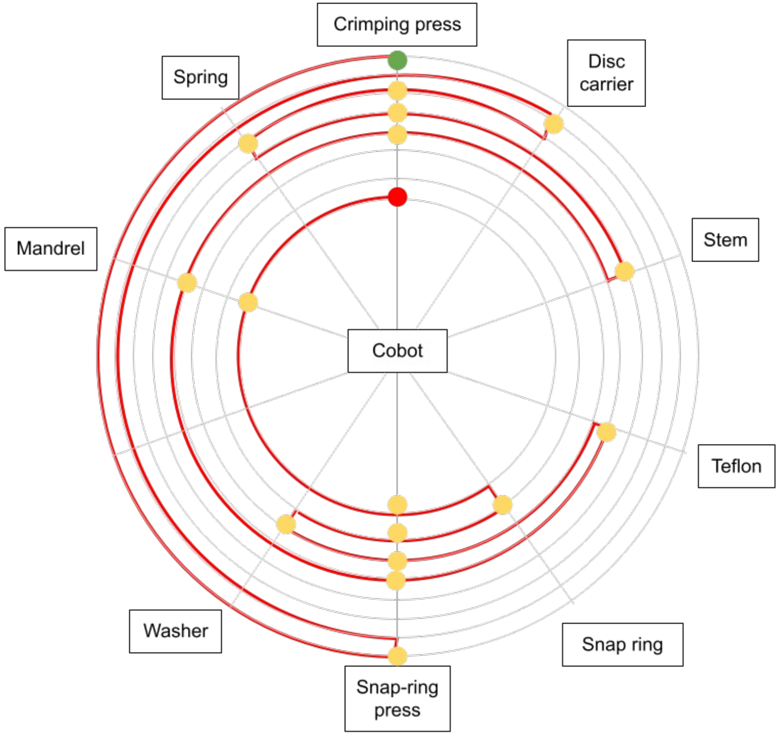
Note: Parker also has a contract with ABB robotics, so they already have a good relationship and other contacts established.

# Layout of the robot tool-path

| | GoFa | Swifti |
|---|---|---|
| Time for one cycle of the path | 9.8 s | 2.6 s |
| Parts made in one hour | 129 | 174 |
| Required output per hour | 40 | |



# Collaborative Robot Safety Standards

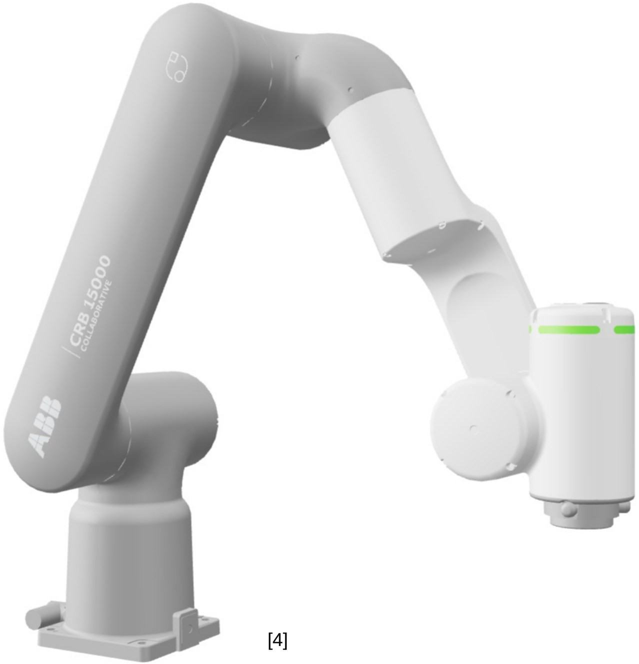
ISO 10218 (2011): Safety requirements for industrial robots

Part 1: Robots

Part 2: Robot systems and integration [7]

ISO/TS 15066 (2016): Safety requirements for industrial robots

Collaborative operation [8]




[4]

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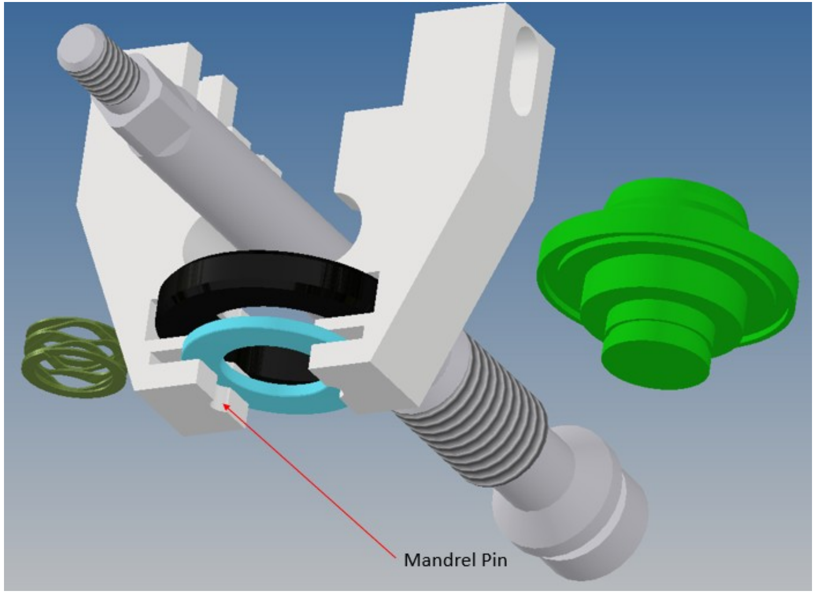
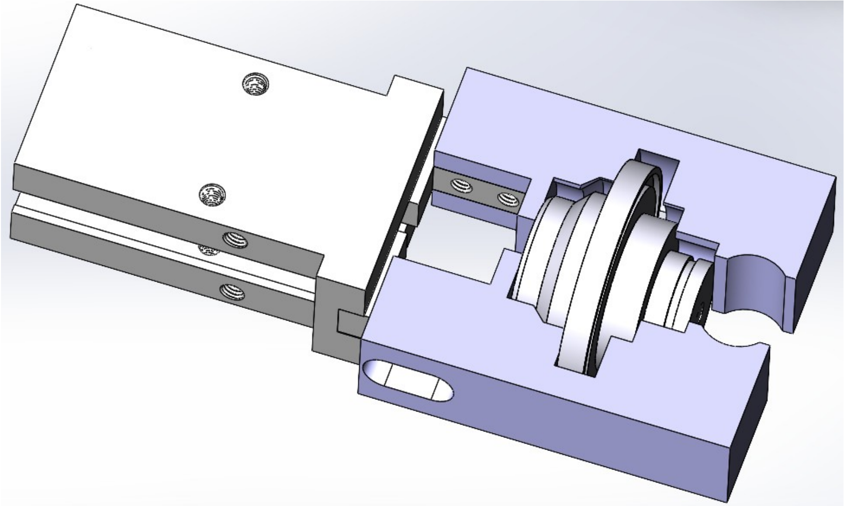
# Pneumatic Grippers

# Finger designs were iterated with Parker Engineers



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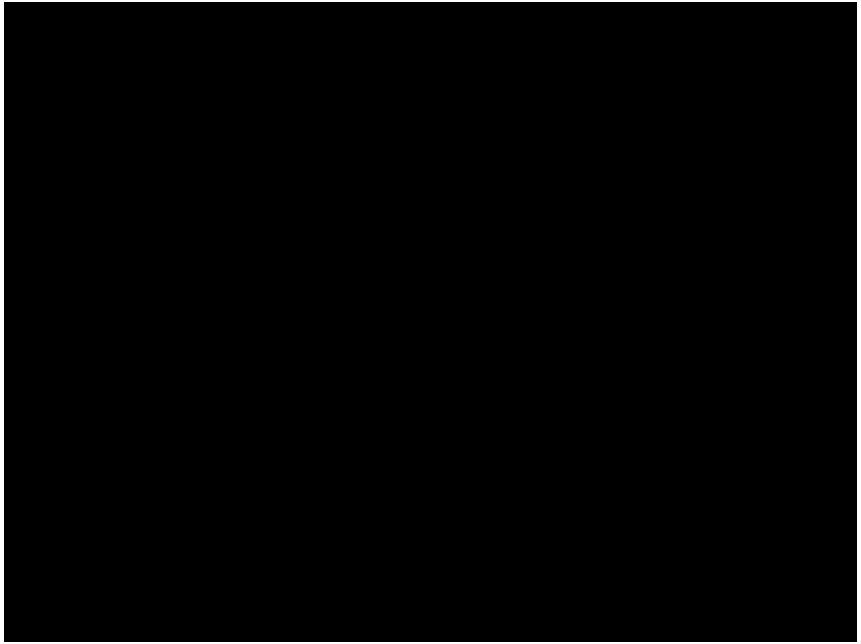
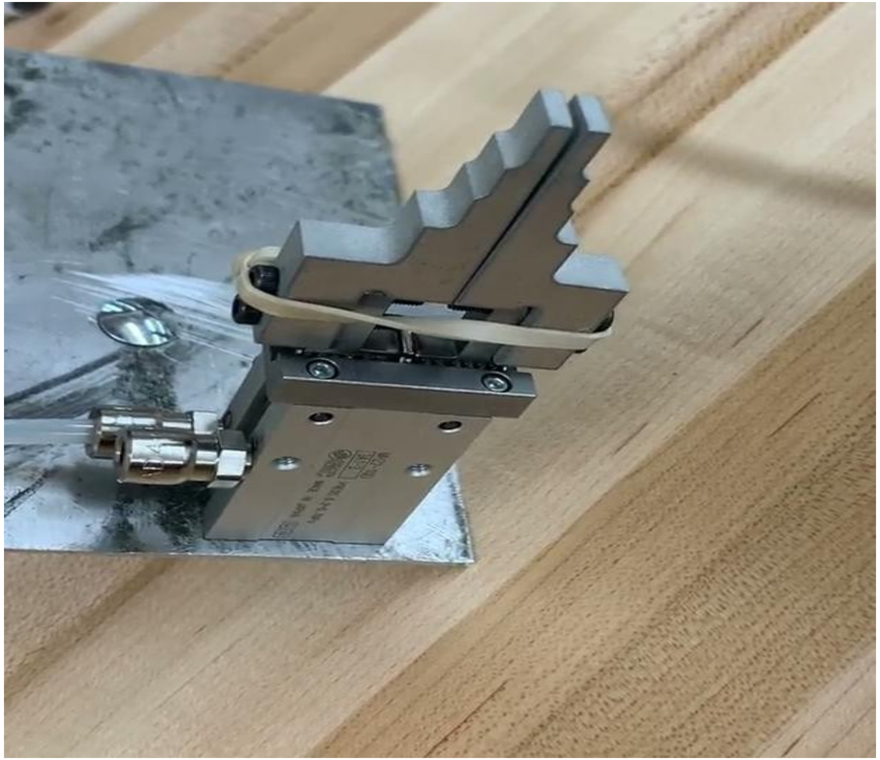
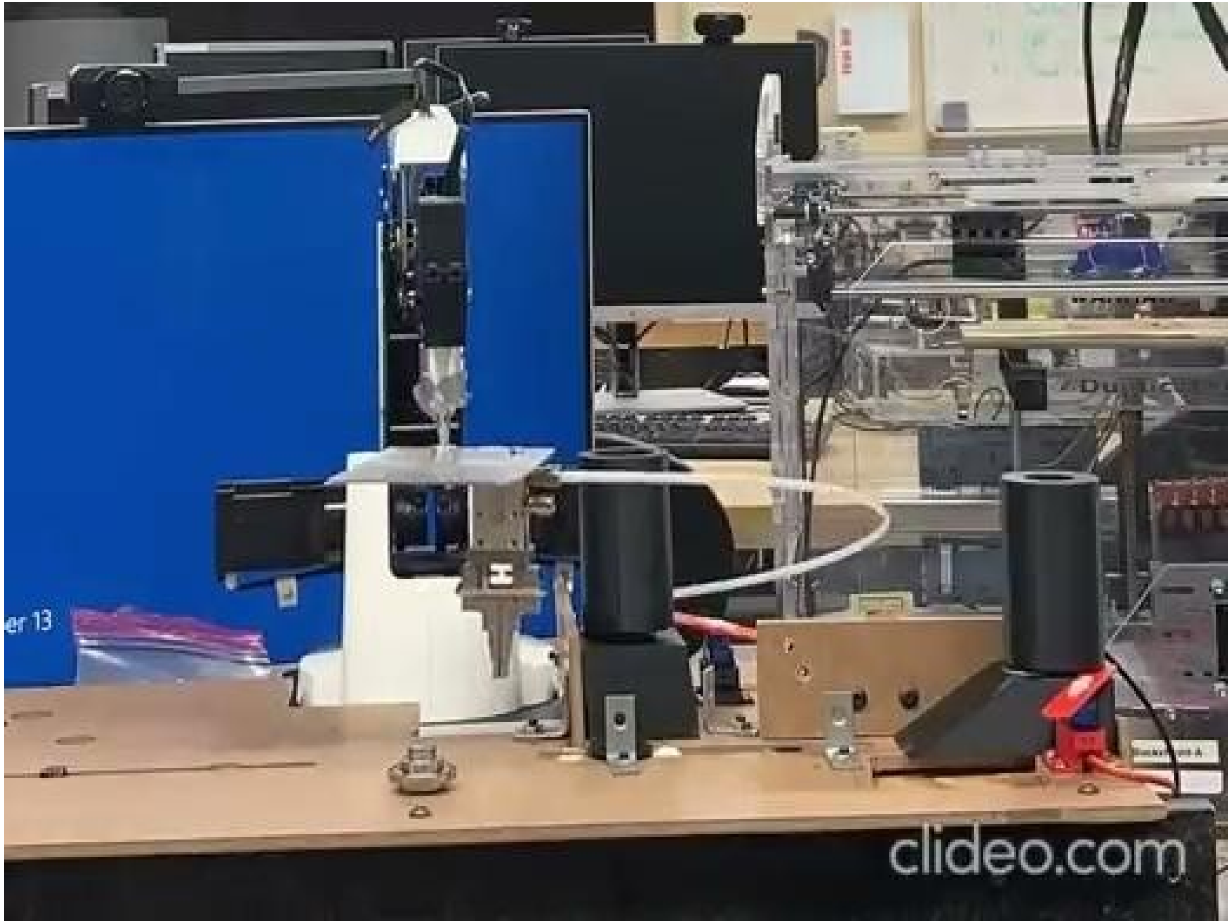
# We have two working prototypes: One for OD and one for ID



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# Crimping Press Design

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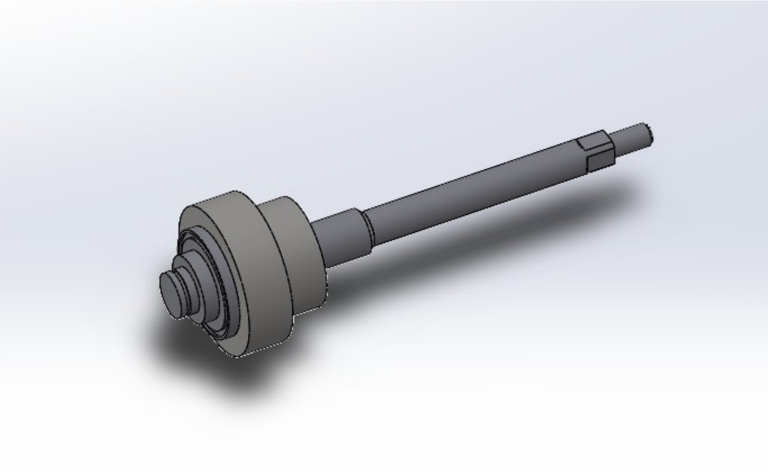
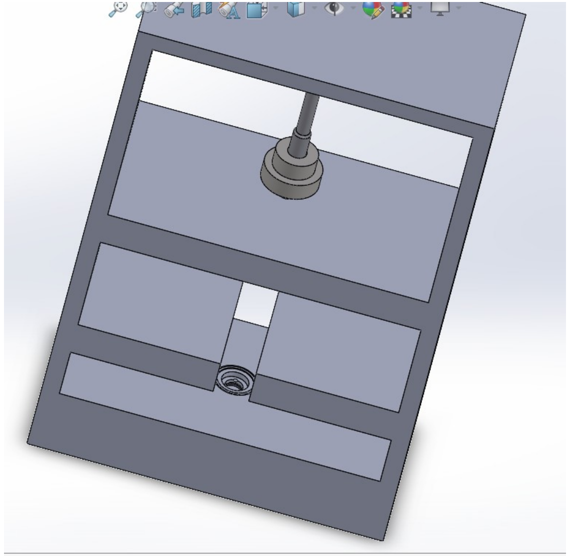
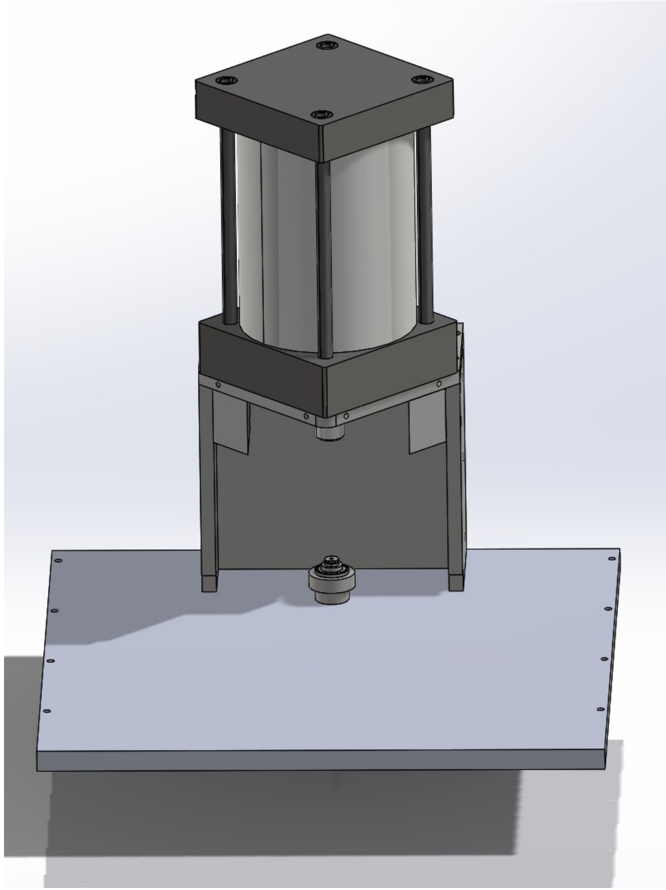
# The crimping step won't utilize Parker's existing press design

- Mold for disc carrier to fit into
- Crimping coupling tool to transmit force between the stem and the disc carrier, allowing the wave spring to crimp



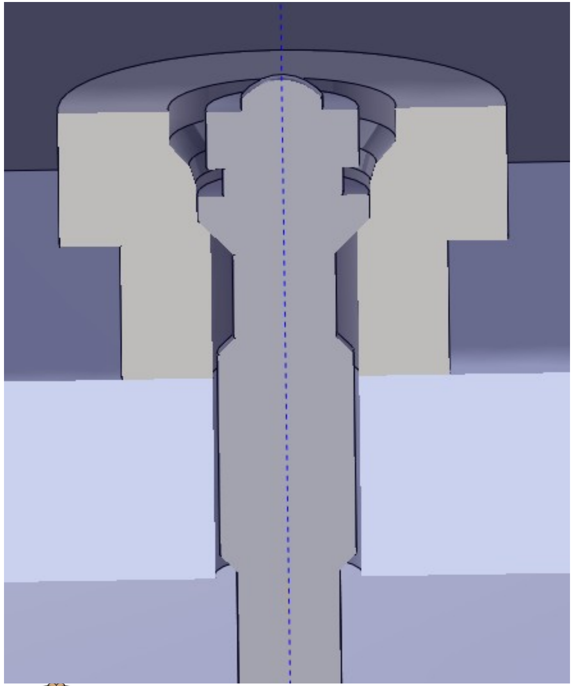


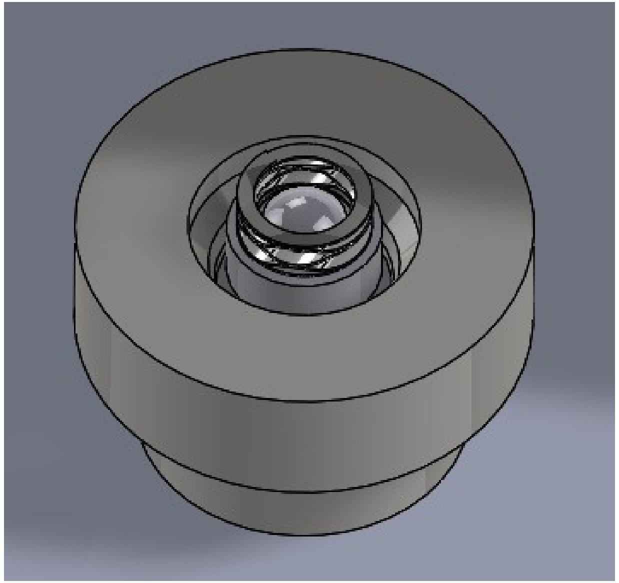
# Improved Press Design



# The molded stem holder prevents overpressing.

- Required inlet pressure needs to be larger than 90 psi to sufficiently crimp.
- Cylinder Bore is 6 in





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# Snap-Ring and Mandrel Design

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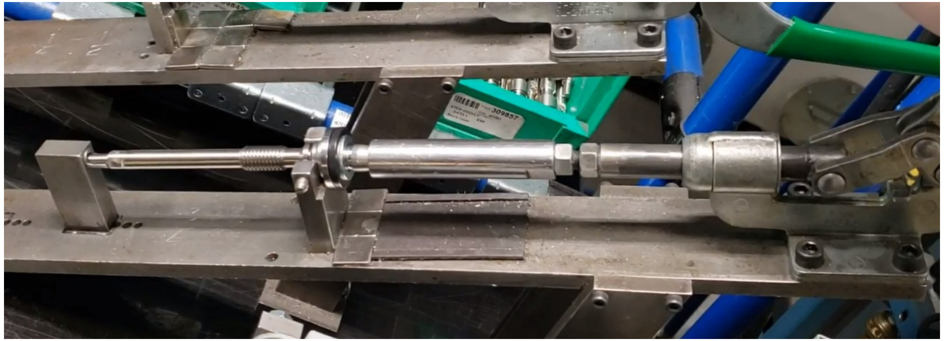
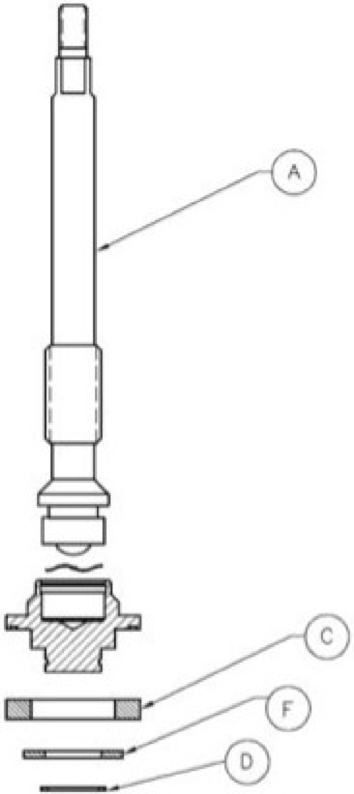
# Current Snap Ring Process

- Teflon (C), washer (F), snap ring (D), and crimped stem assembly (A)
- Snap ring is placed on a mandrel and placed on the same axis as the disc carrier stem assembly
- Clamp the snap ring on the assembly with the solid collet



Current hand-powered snap ring clamping press

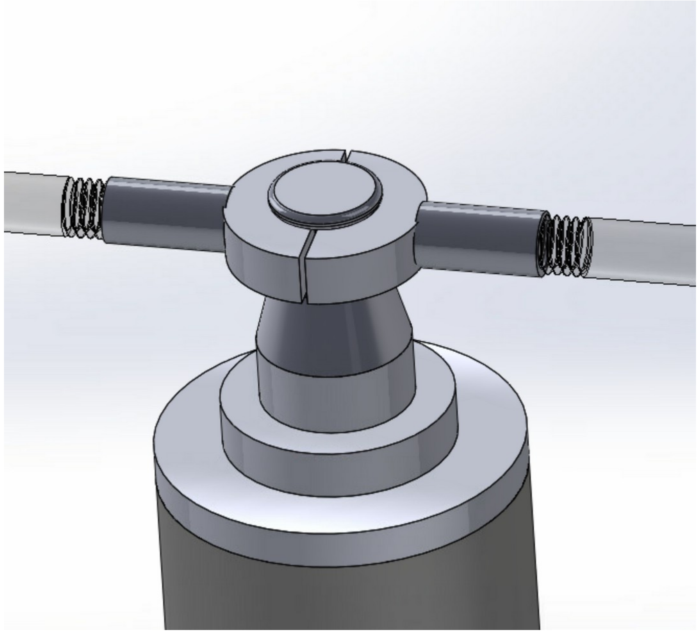
Zoomed in image of mandrel



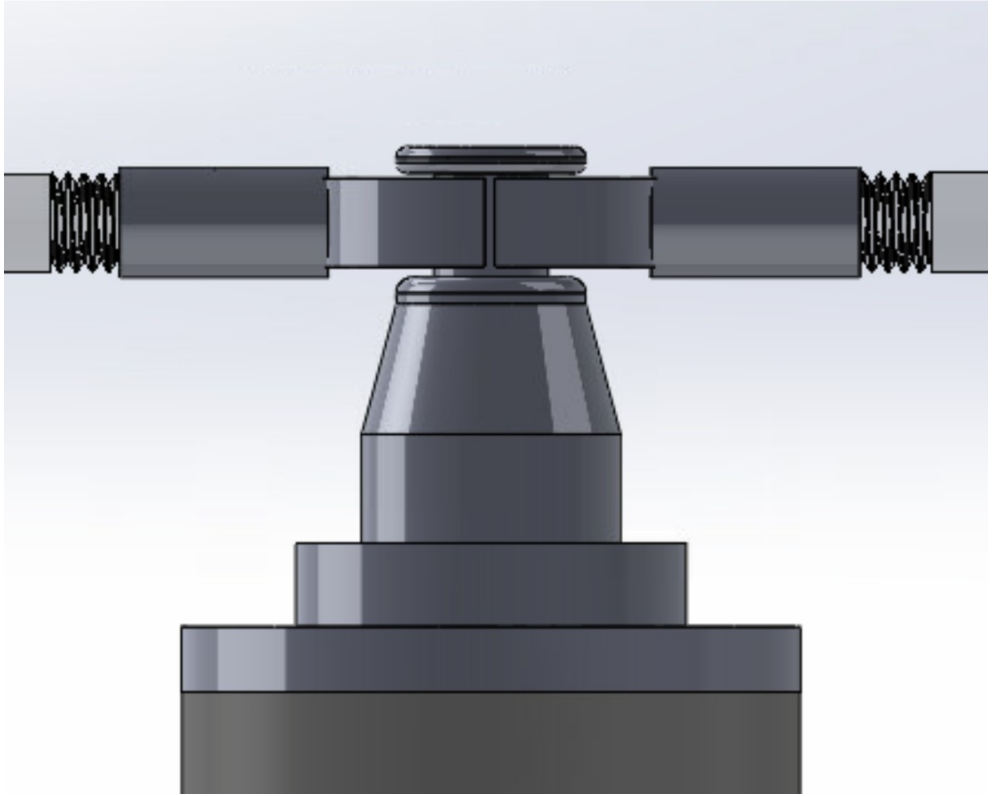
# New Design

- 6 steps
- Teflon, washer, and snap ring are added when mandrel is on and side actuators are retracted (step 2 in video)

# New Design - Gripping the Mandrel

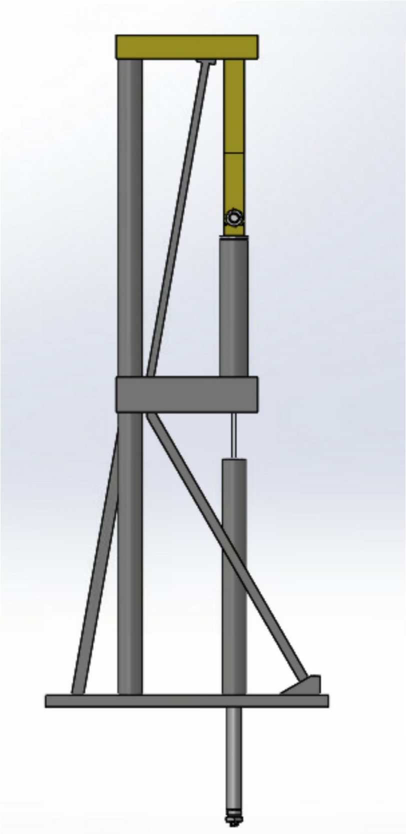


Top view of grippers with mandrel



Front view of grippers with mandrel

# Support Structures



Side view of press to show support structures

Bending Load:

$$S_n = S_n' C_L C_G C_S C_T C_R \quad (1)$$

Aluminum yield and ultimate stress [14]:

$$S_n' = 4.5\ ksi$$

$$S_u = 12\ ksi$$

From the Juvinall textbook [14]:

$$C_L = 1,\ C_G = 0.9,\ C_S = 0.8,\ C_T = 1,\ C_R = 1$$

From equation 1…

$$S_n = S_n' C_L C_G C_S C_T C_R = (4.5)(1)(0.9)(0.8)(1)(1) = 3.24\ ksi$$

Bending Stress:

$$\sigma_{nom} = Mc/I \quad (2)$$

Where the bending moment,

$$M = F * x = 9.47[lb] * 5[in] = 47.35[lb - in] \quad (3)$$

The moment of inertia about the neutral axis,

$$I = 0.5 * m * r^2 = 0.5 * 1.11 * 0.5^2 = 0.1388\ [in^4] \quad (4)$$

The distance from the neutral axis,

$$c = 0.5\ [in] \quad (5)$$

Resulting in a bending stress of 170.6 [psi]

Axial Load:

$$\sigma_a = F/A = mg/A = (11.7lb)(32.174ft/s^2)/(3.1415 * (0.5^2)) = 479.29\ psi \quad (6)$$

Goodman's:

$$(\sigma_a/S_n) + (\sigma_m/S_u) = 1/n \quad (7)$$

$$(479.29/(3.24 * 10^3)) + (170.63/(12 * 10^3)) = 1/n$$

$$n = 6.181\ SF$$

This demonstrates that support structures are not required, however it would be beneficial as the support structures will improve stability and reduce the chances of failure.

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# Conclusion

Feeding System → Robot → Crimping Press → Snap-Ring Press

We've shown a viable way to automate the assembly of handvalve stems.

For the future, Parker is pursuing another direction for their handvalve stems, but the concepts and research we worked on will hopefully be helpful for their future automation projects.

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# Thank you. Questions?

By: Ahmed Khalil, Megan Sindelar, Hannah Fibikar, and Erik Svetin

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