Vein Compression Experimental Support System

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Overview

Create a device that helps scientists do experiments on silicone veins. The tool should compress the veins radially, similar to how veins get compressed inside our bodies. This will help scientists study diseases that cause blood clots, like Deep Vein Thrombosis and Pulmonary Embolism.

Design Requirement

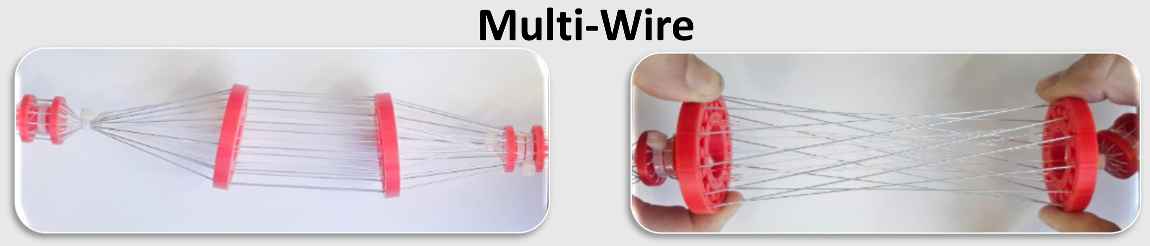
Design Requirements		
Met	Device footprint is 2.5 ft by 4 ft	2 ft by 2 ft by 1 ft
	Can accomodate different sizes of veins	
	Reach a minimum flowrate of 100 mL/min	-
	Repair in 1 hour or less	-
In Progress	Device does not tear veins	✓
	Does not Leak	-
	Parts available within a week or less	✓
	Compression data through a camera	X
Not Met	Multiple inputs (Sine, Ramp, Rounded square)	✓
	Test zones are clear and visible	✓
	Can fit under a microscope	-
	Provides compression of 100 Kpa	-

Design Selection

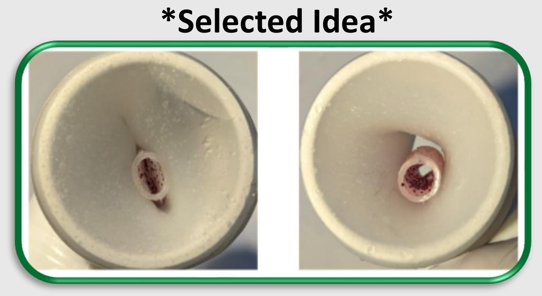
Screening implemented on different design requirements that the device must accomplish in its use.

Design Criterea	Wire Compressio	Air Compression	Water Compression
See-through	4	3	3
Radial Compression	2.2	2.9	3.6
Compressibility	4	4	4
Setup time	5	5	5
Scalability	5	5	5
Zone Control	3	4	4
Reaction Time	4	4	4
Total:	3.27/5	3.57/5	3.81/5

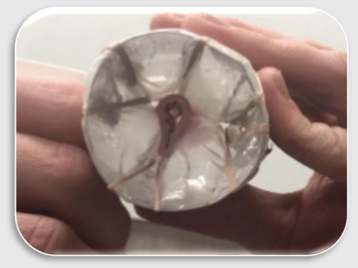
Multi-Wire



Selected Idea



Hydraulic Compression Sleeve



Pneumatic Pressure Cuff

Experiments & Analysis

Calculations of Required Motor Output Diameter: Diameter vs. Stroke

Required volume	30mL	30mL	30mL	30mL	30mL	30mL	30mL
Diameter	10mm	20mm	30mm	40mm	50mm	60mm	70mm
Stroke $(\frac{V}{\pi r^2})$	382mm	95.5mm	42.4mm	23.9mm	15.3mm	10.6mm	7.8mm
Speed required $(\frac{Stroke}{0.1})$	3820mm/s	955mm/s	424mm/s	238mm/s	153mm/s	106mm/s	77.9mm/s
Force Required $(\frac{0.5mv^2}{Stroke})$	570mN	143mN	64mN	36mN	23mN	16mN	12mN

Calculation of Syringe Friction & Force on Plunger

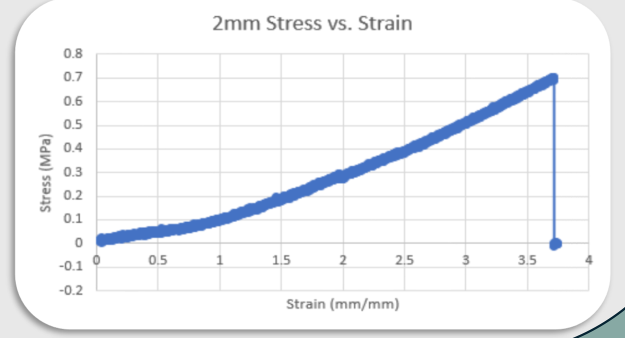
Force = Pressure x Surface Area

Force = 2 bar x pi * 0.02m^2

Force = 251 Newtons = 25.7 kgf

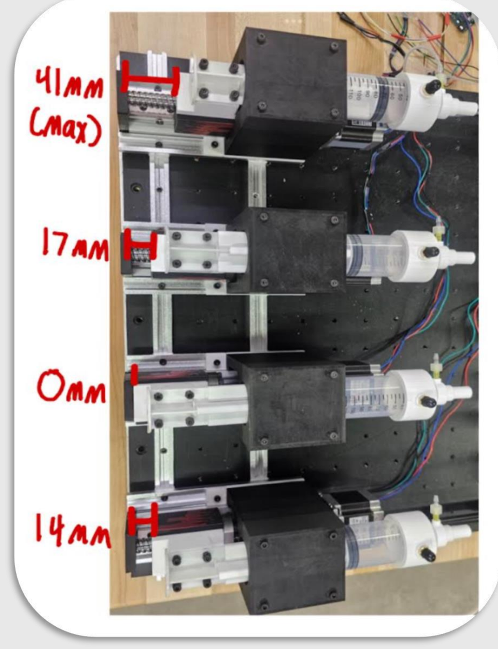
Calculation of Strength vs. Friction of Silicone

Tensile Test Data of Silicone Dog bones



Results

Code enabling the user to modify pulse width, delay time, and frequency parameters of a set input.

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'w' to increase PULSE_WIDTH
's' to decrease PULSE_WIDTH
'a' to increase DELAY_TIME
'd' to decrease DELAY_TIME
'f' to increase frequency
'g' to decrease frequency
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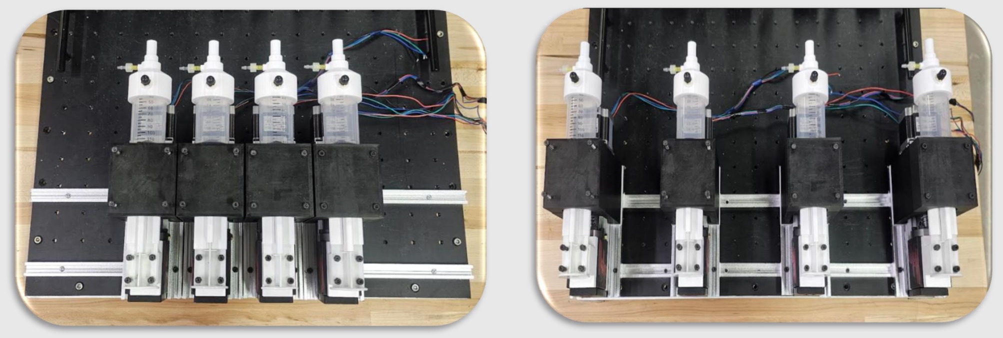
Different Inputs Allowed:

- Sine wave
- Rounded Square
- Ramp

Scaling Between Different Vein Sizes

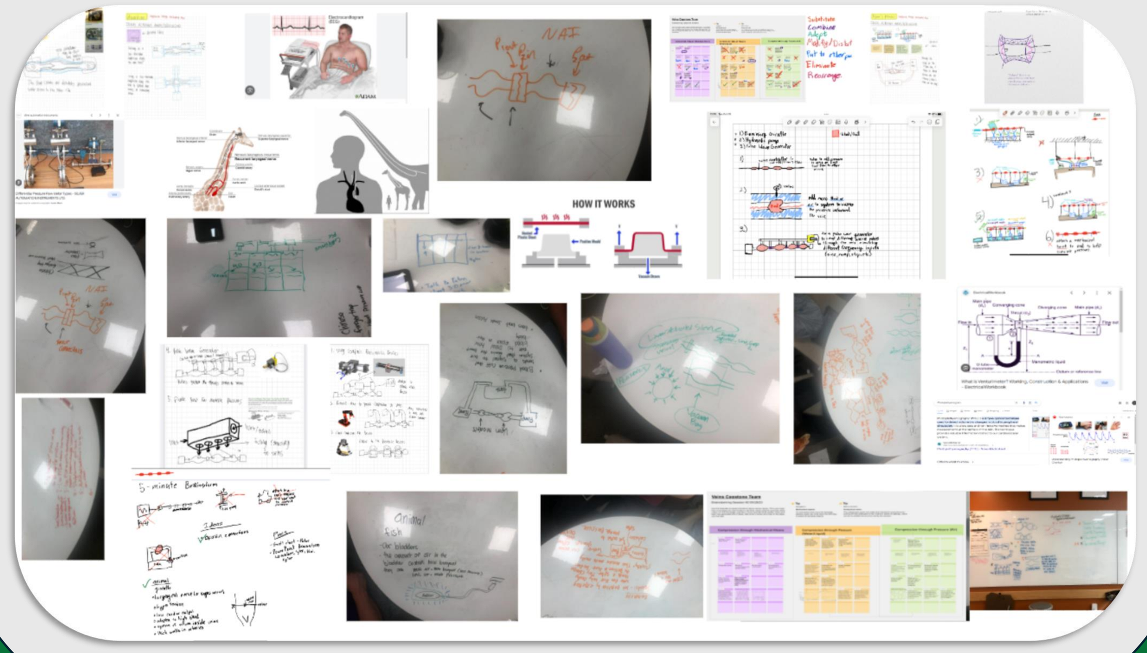


Idea Generation

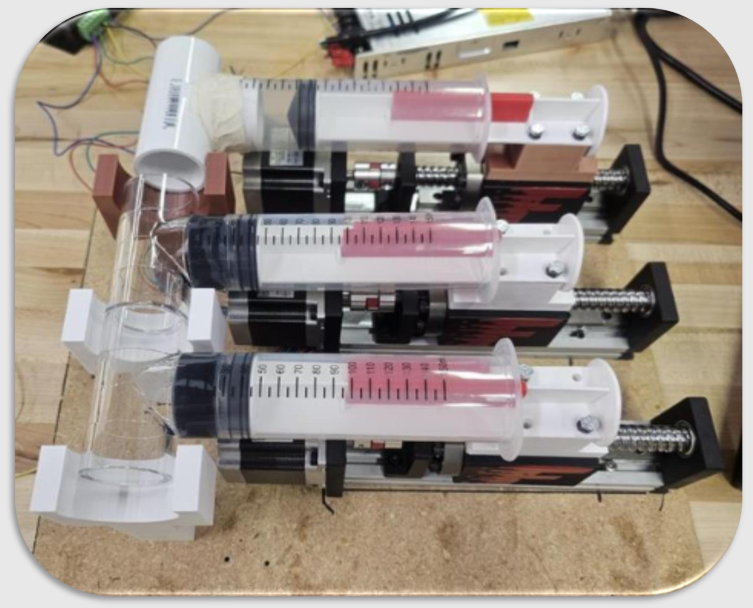
Techniques used

- Brainstorming
- Biomimicry - Look to nature for inspiration. See how animals and plants solve problems and then apply those solutions to human challenges.
- Restricted Root Idea - Focus on one specific part of a problem or concept.
- SCAMPER

Over 100 ideas created and narrowed down to the top 3.



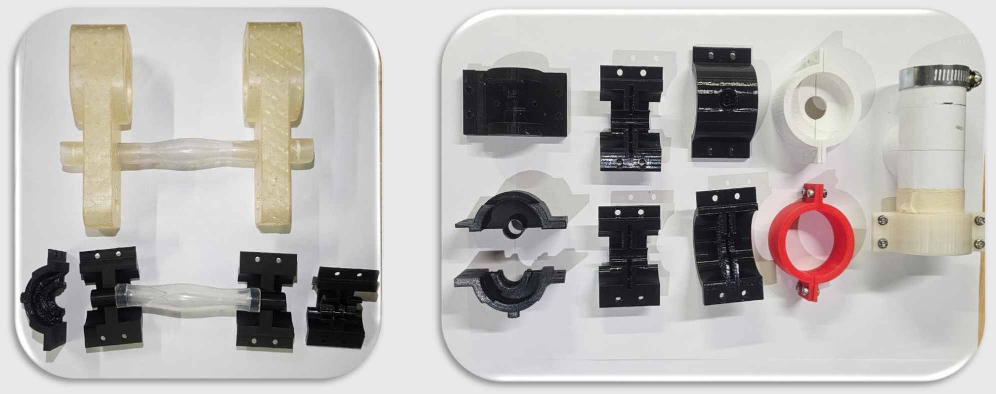
Prototyping



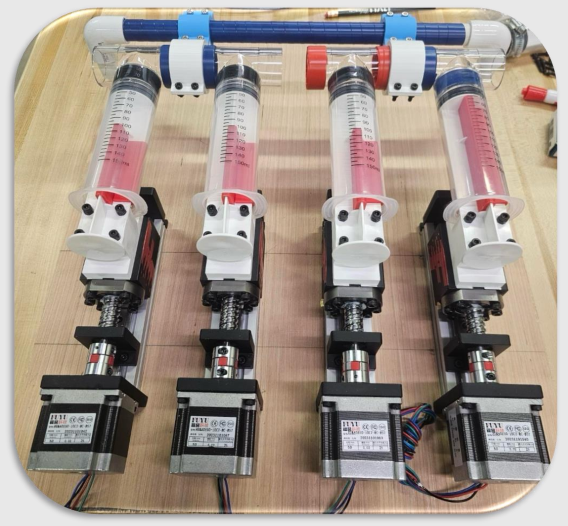
First installment of the device in order to test the linear actuators.

Iteration of Parts

Evolution of coupling system



Concept Refining

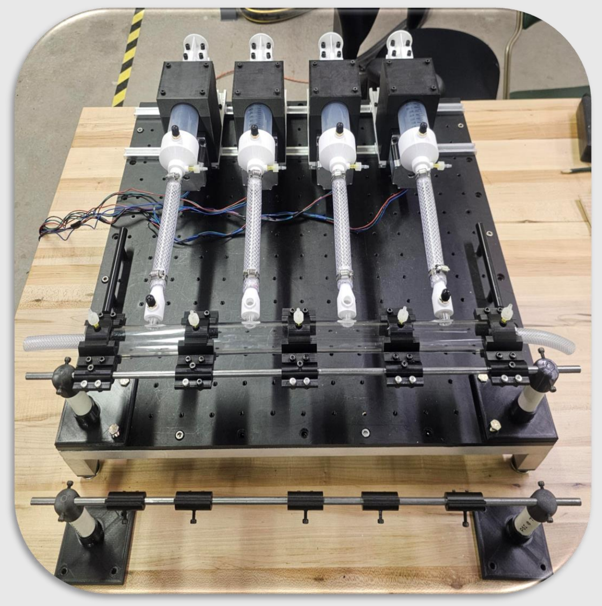


Second installment that stopped T-fittings from moving and the following design choices:

- Bar installed to keep each section placed together correctly.
- Each individual system spaced to accommodate large veins.
- Silicone veins fitted in between each section with coupling.

Third installment that allows for future microscope usage on each section.

Current Design & Future Plans



Current Design

- Successfully provides sine wave, rounded square, and ramp to each actuator.
- Has four independently controlled zones.
- Test sections are clear and visible.

Future Plans

- Get pressure sensor data for each required section.
- Adapt so test sections can fit under a microscope.
- Fully accommodate all vein sizes.