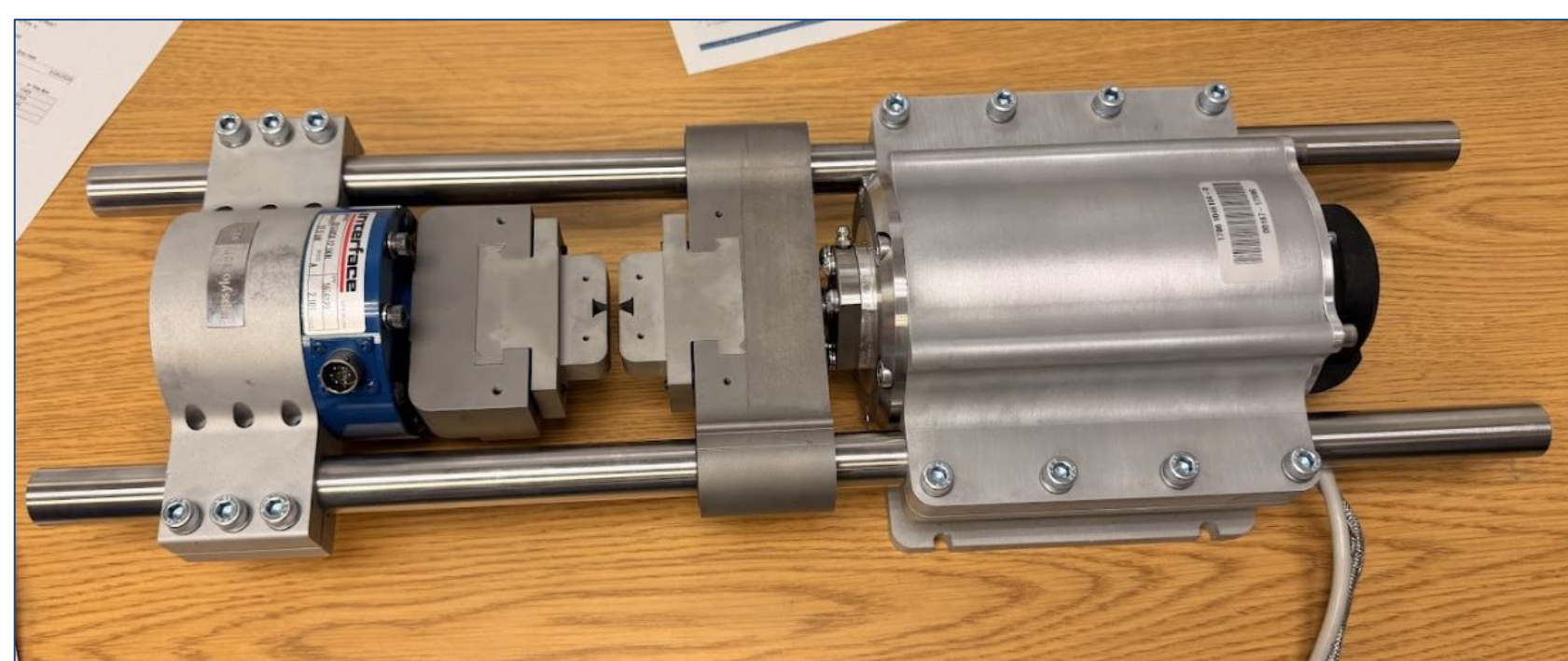


Motivation, Goal, Impact

To design a automatic tensile testing machine for the Naval Surface Warfare Carderock Division (NSWCCD) that reduces long human operation hours.

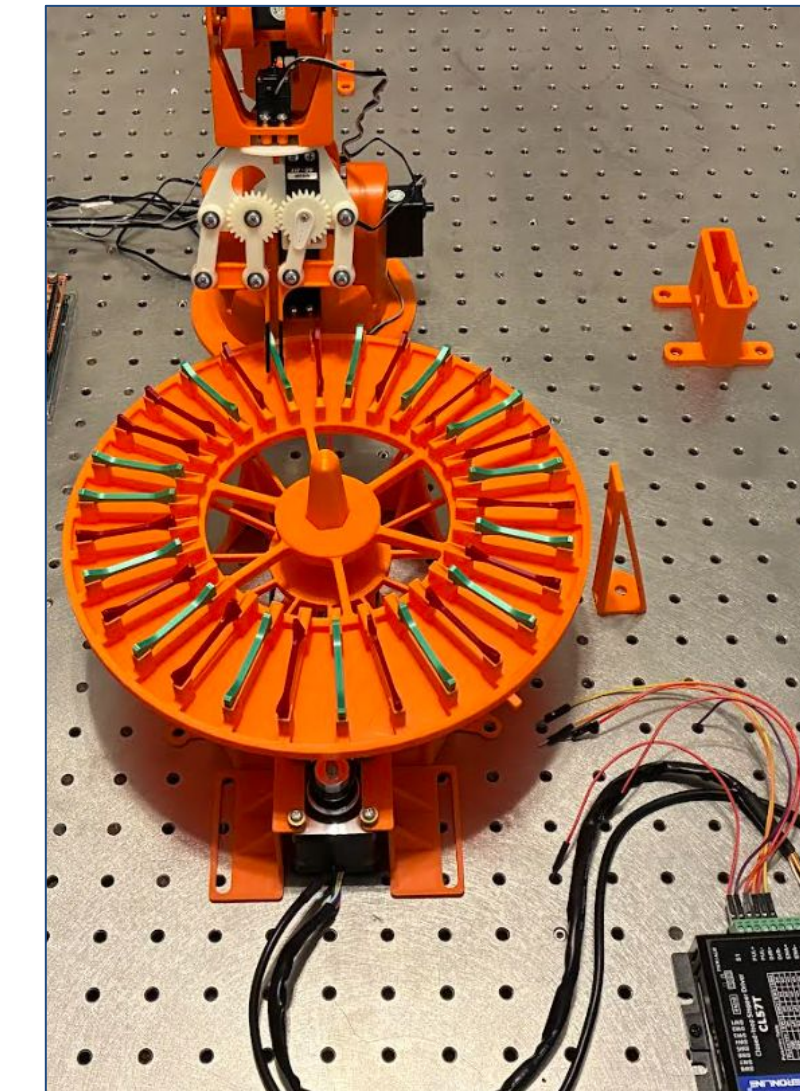
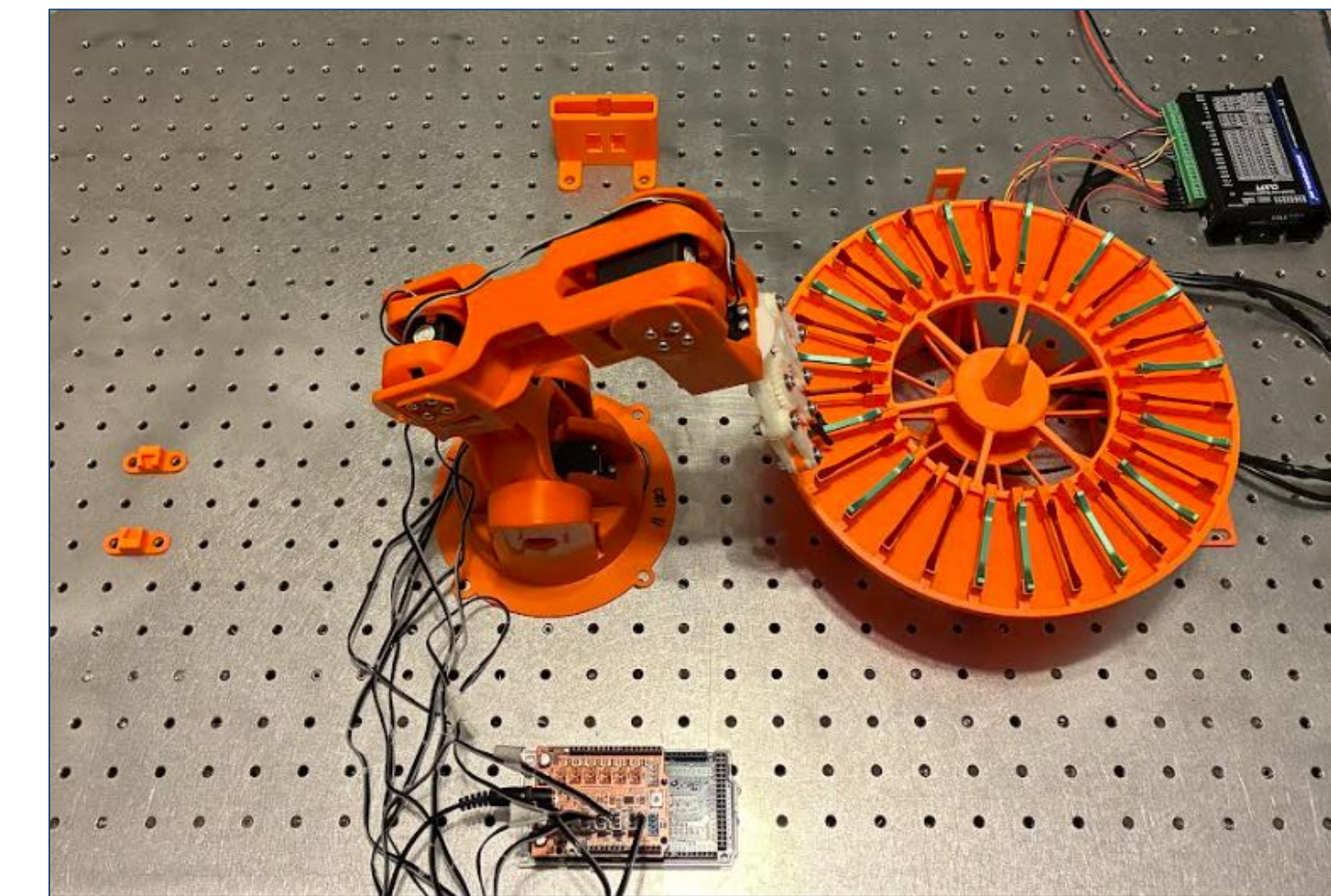
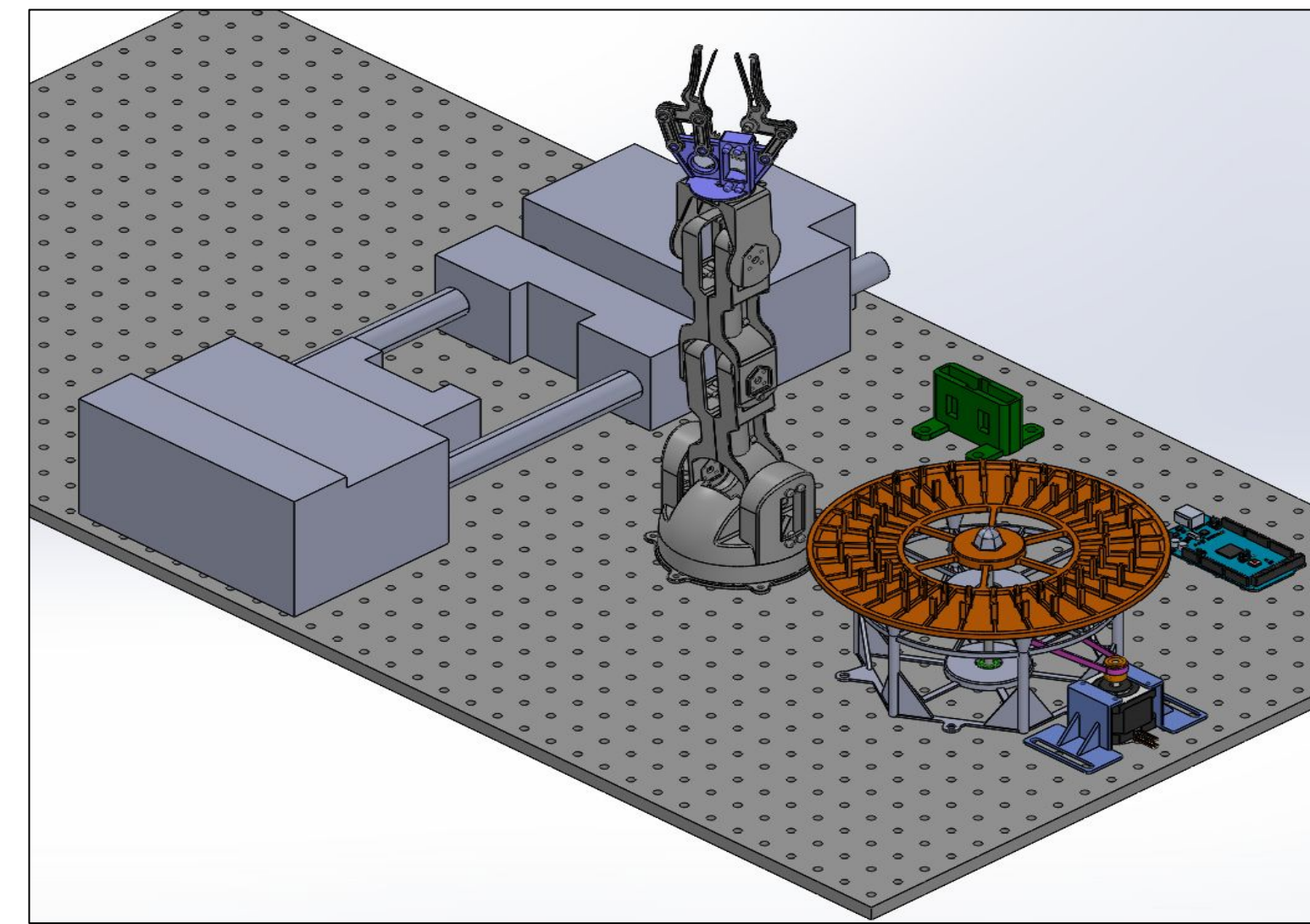


Requirements

Requirements given directly by NSWCCD:

- Load, test, and unload each sample of the batch without human intervention
- Preload 30+ metallic specimens into loading environment
- Ability to conduct tests on 2mm, 3mm and 5mm wide dogbone samples
- Reliably sort broken sample halves after testing is completed

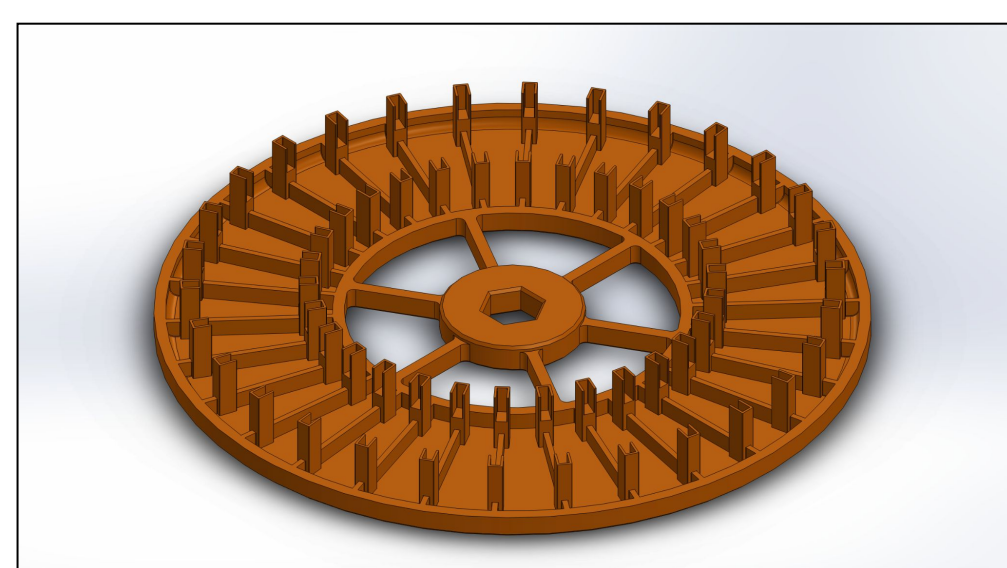
Final Design



The automated workflow integrates four substations: a cobot arm, a rotary carousel, a beam-break/re-orientation station, and a tensile test machine. The cobot retrieves a specimen from the carousel, passes it through the beam-break sensor to confirm grip and re-orient it flat, then loads it top-down into the tensile tester. Once the test completes, the grips return to their home position, the cobot extracts the fractured specimen back to the carousel, and the carousel indexes 6° to present the next specimen.

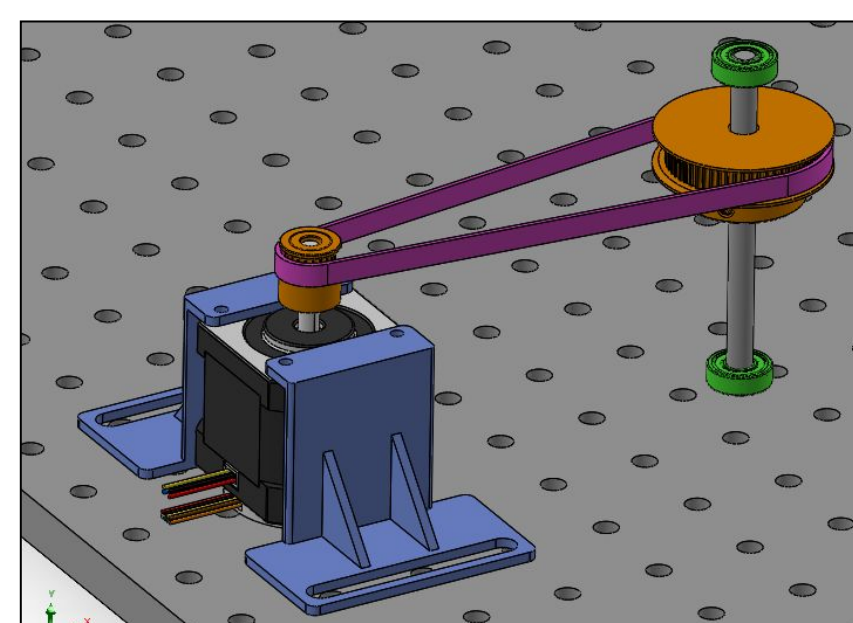
Design Calculations & Decisions

Carousel Loading Tray



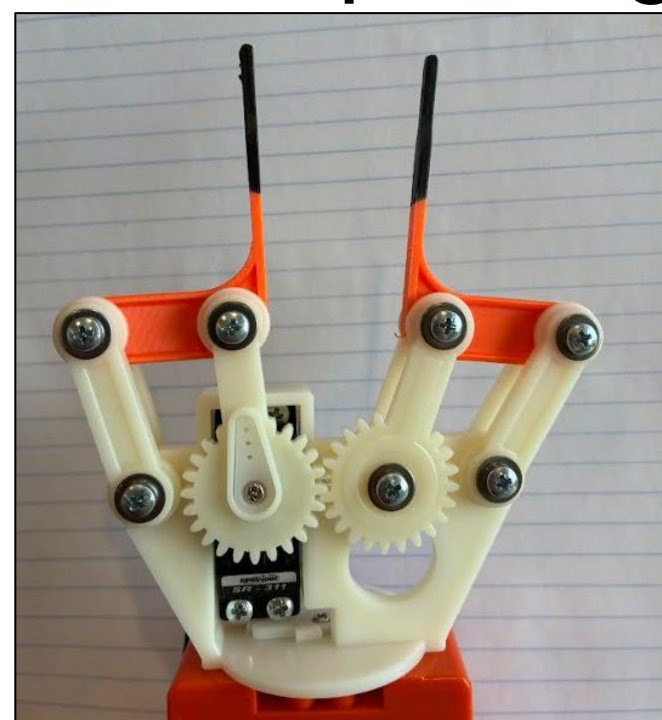
The carousel tray was designed so that all 3 sample sizes are picked up at the **same fixed location: 90 mm** from center, **18 mm** height. The orientation geometry of the samples was important to allow for seamless pickup using a robotic arm.

Carousel Rotation Design



The carousel must rotate an exact **6°** to bring as new sample to the same location after each rotation. A **3:1** timing belt ratio was implemented to convert the motors 1.8° rotations into precise **0.6°** degree rotations. A **10 step** sequence was implemented after this to rotate an exact 6°.

Cobot Grip Design



Utilized Creo Design Optimization Study to redesign cobot arm grips for sample placement in small gaps on 2mm sample tests. Envisioned a “worst case force” scenario that would introducing buckling failure to the grips. Study iterated on length of grip (**50.34 mm**) until satisfactory safety factor was reached (**1.4**)

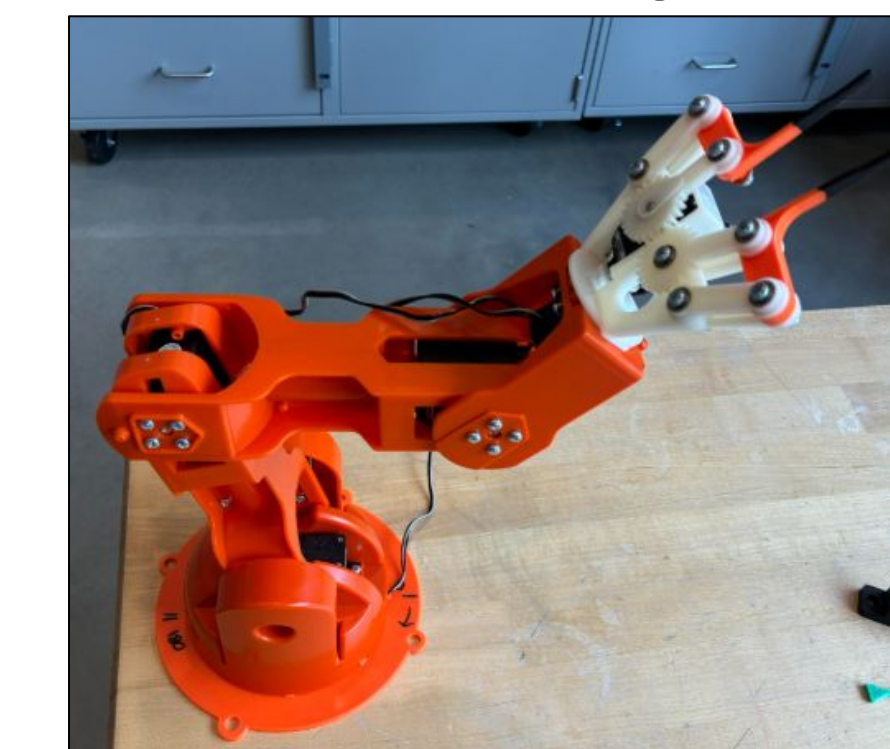
Prototype & Test Results

Carousel Prototyping



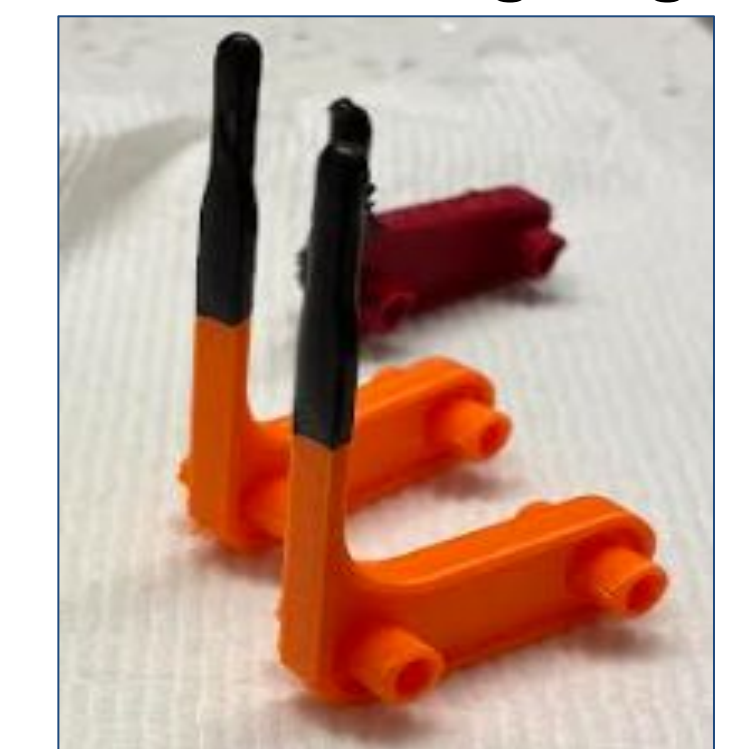
3D printed carousel, motor mount, beam break and reorientation station.

Arm Functionality Testing



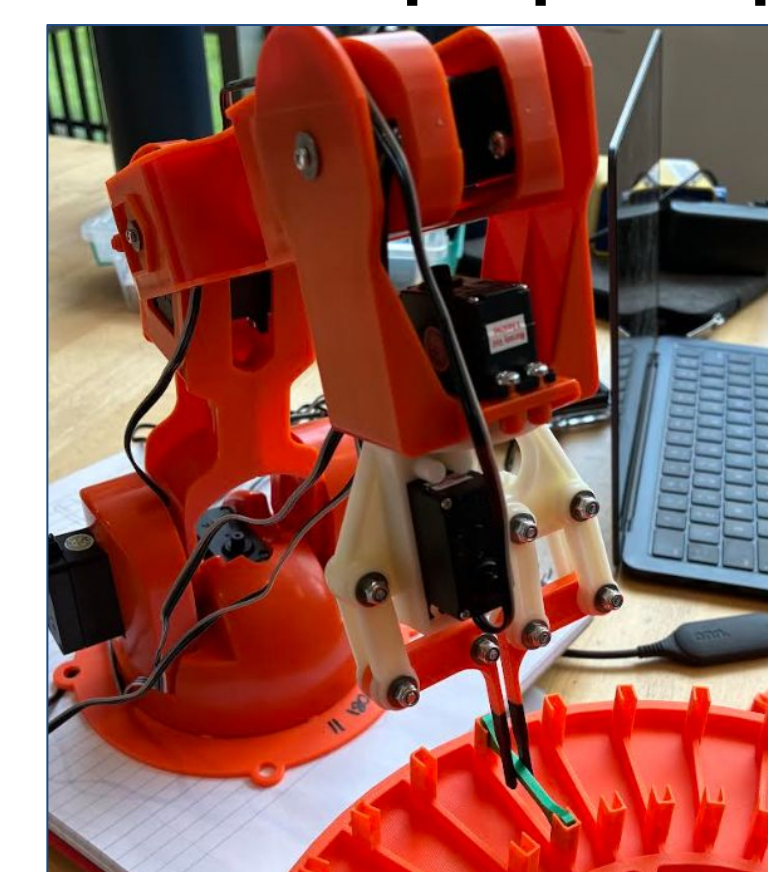
Testing full range of motion of all 6 degrees of freedom on Digikey Braccio T050000 Cobot Arm

Rubber coating of grips



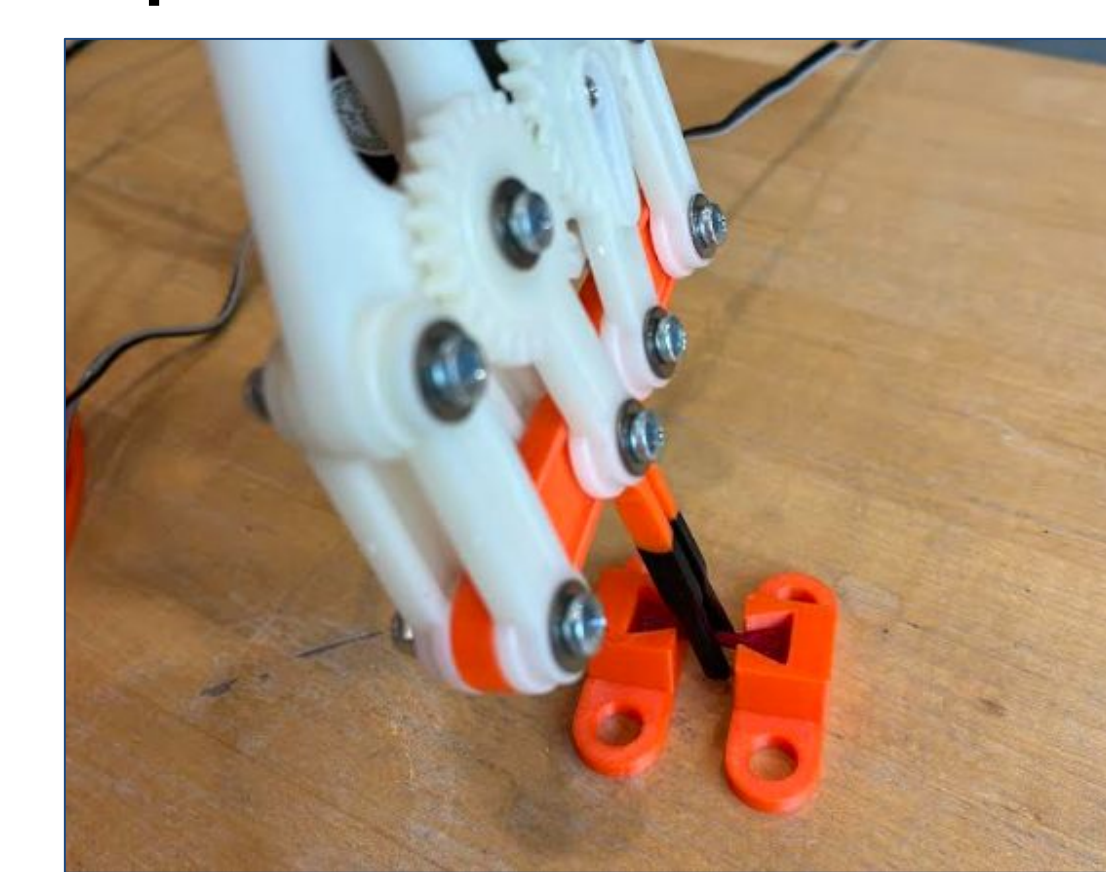
Coated grips with Plasti-dip rubber and saw improved friction between grip and sample

Full sample pick-up



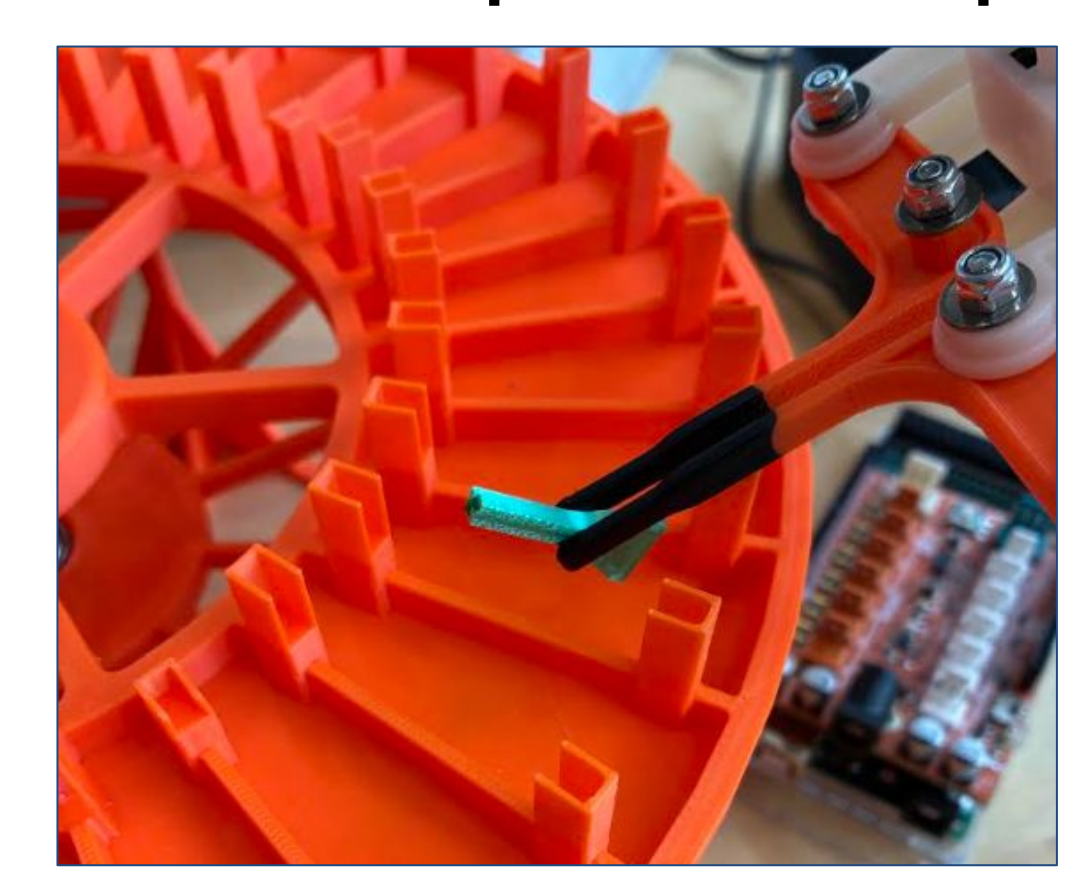
Test results revealed inability to pick up samples strictly vertically. Added incline to sample shelf and saw improved performance

Sample Placement in Machine Grip



Exact performance of sample placement into grips unknown as PsyloTech uTS 10 kN tester grip properties vary from prototype

Broken Sample Half Transport



Smaller grip faces allow for more precise movement, assisting the broken sample half pick up process.