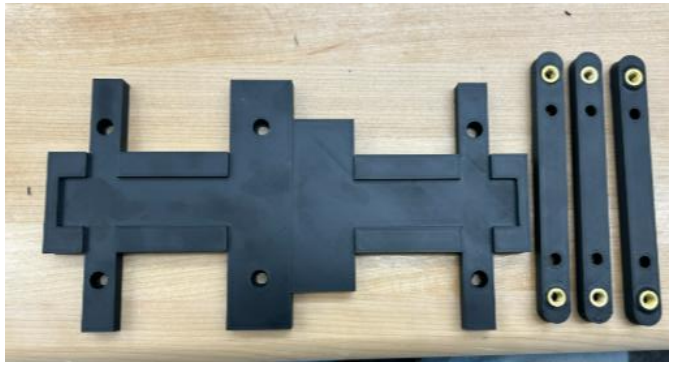
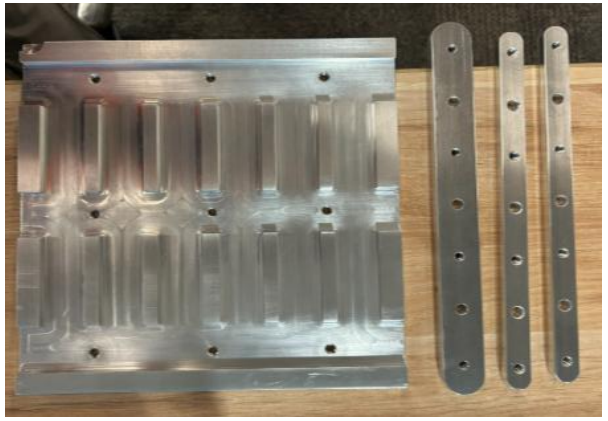
MECHANICAL PROJECTS

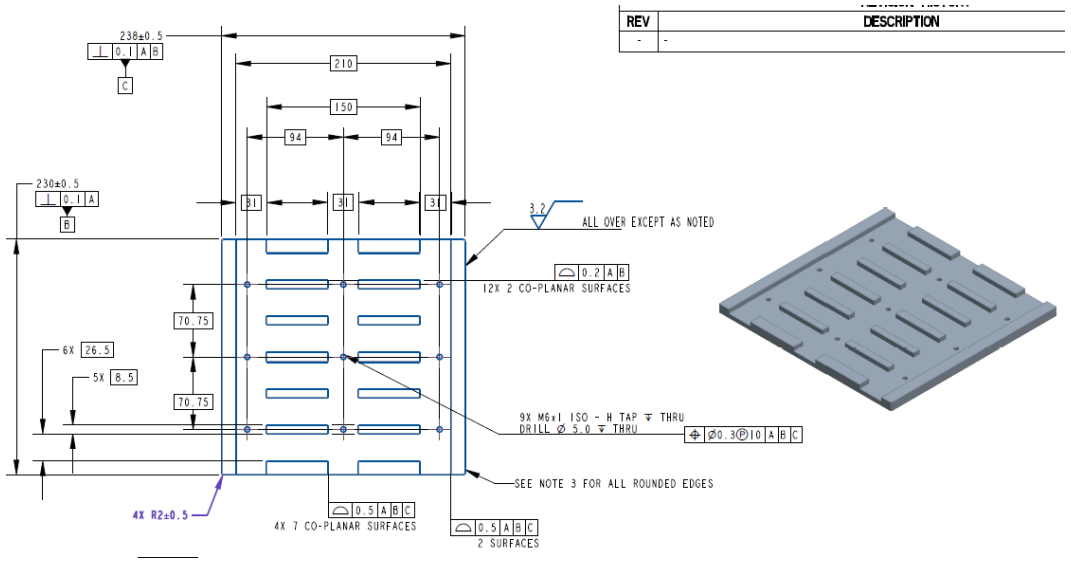
Jig for Preparing Test Samples

Svante

- **Situation:**
  Manual preparation of test coupons for mechanical validation resulted in inconsistent geometry and poor repeatability.
- **Task:**
  Design a repeatable jig to produce uniform test samples for adhesive and mechanical tests.
- **Action:**
  Modeled jig components in **Creo**, applied **GD&T**, optimized material selection, and iteratively improved **3D-printed prototype** for strength and manufacturability before transitioning them to machined parts
- **Result:**
  Reduced sample preparation time by 40% and improved test result consistency across multiple trials.

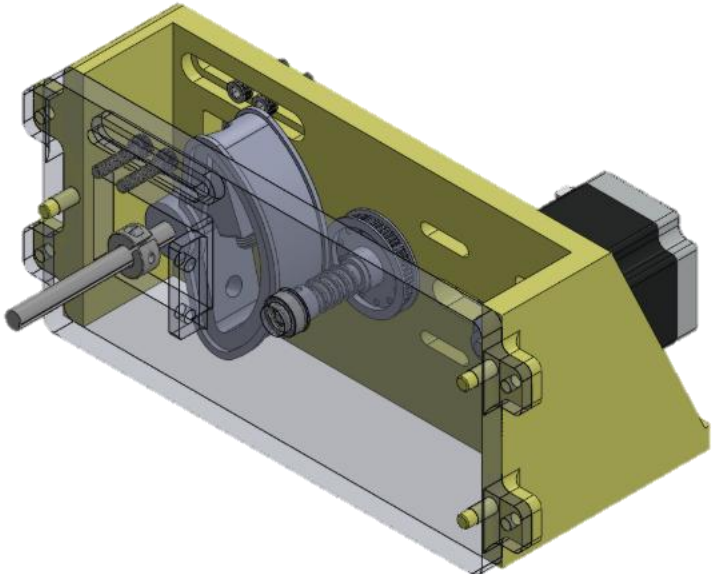


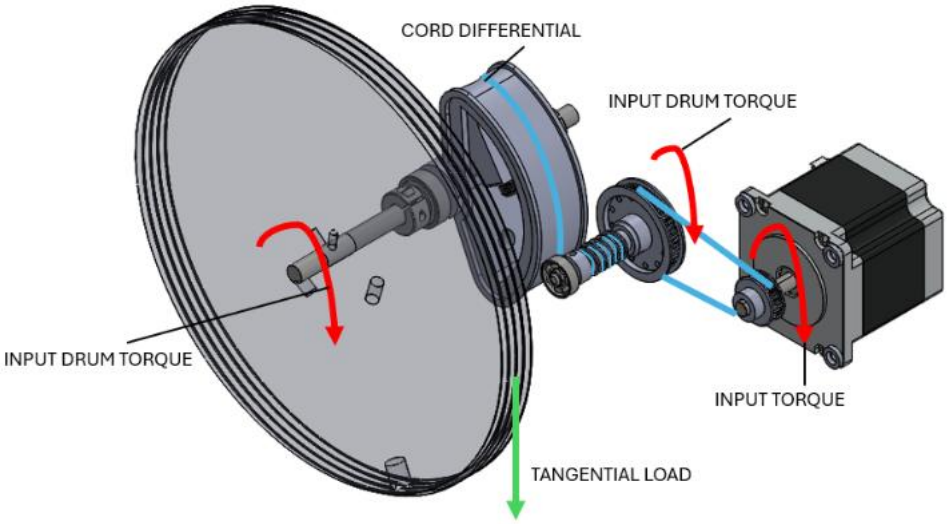




Capstan Drive Feasibility Study

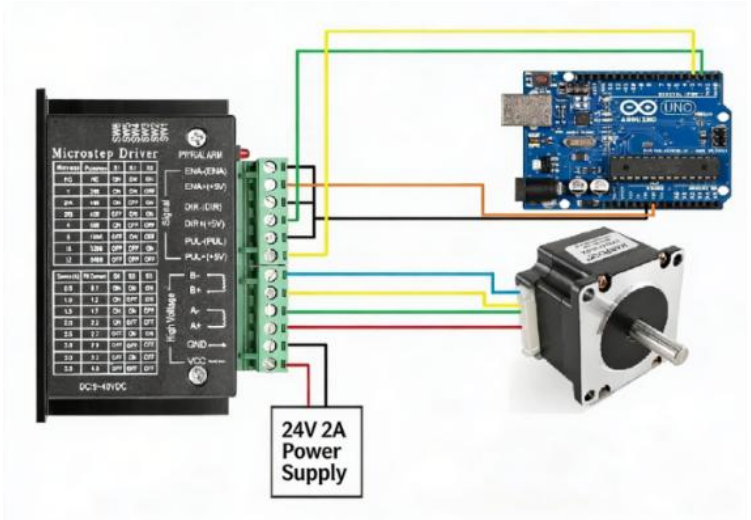
- **Situation:**
  Current powered knee-ankle-foot orthoses rely on planetary gearboxes for torque transmission. The team was tasked with investigating whether a capstan-based drive could serve as a lower-backlash, mechanically simpler alternative for assistive knee actuation.
- **Task:**
  Design, build, and validate a bench-mounted capstan drive proof-of-concept against the following requirements:
  - 0° to 120° rotational range of motion
  - 22 Nm continuous output torque
  - Less than 1° backlash
  - 100,000 cycle endurance under load
  - Overall gear ratio of at least 40:1
  - Operation at driven speeds up to 80 RPM
  - Cord diameter of 1 ± 0.2 mm

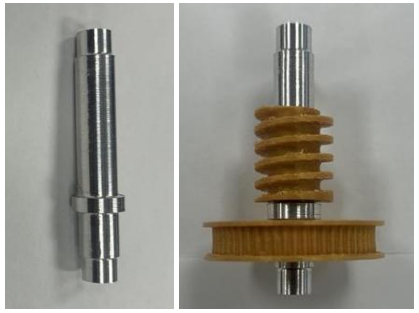


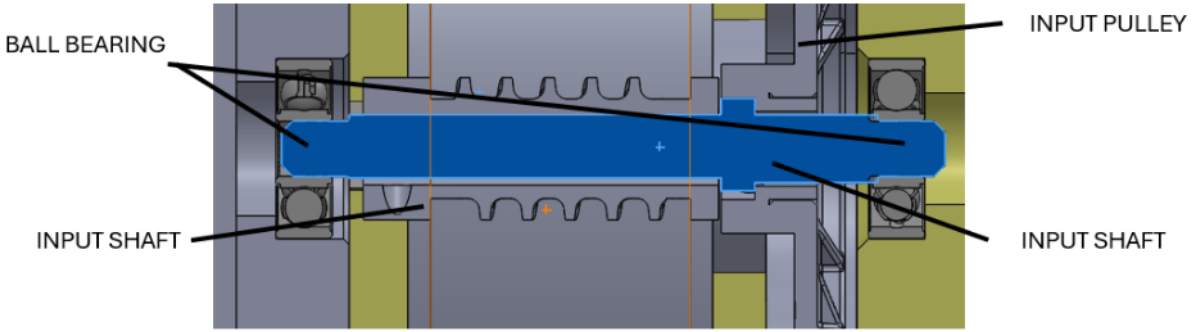


Capstan Drive Feasibility Study

- **Action:**
  - Led the full electrical system architecture, selecting and integrating a **NEMA 23 stepper motor**, **DM556 driver**, and **Arduino Nano** into a functional test bench
  - Wrote modular Arduino **firmware** for the stepper motor with configurable speed and range of motion, a homing routine for **repeatable** test references, **cycle counting** for endurance tracking, and an end-of-travel **deceleration** profile to prevent impulse loading on the cord
  - Ran all torque, endurance, and positional accuracy tests, including calculating output torque, amplification ratio, and identifying performance-limiting factors
  - Developed the **BOM** and coordinated part procurement with the client
  - Spent **20+ hours** in the machine shop across multiple iterations machining the aluminum and steel input shaft on a **lathe** and **mill**
- **Result:**
  Demonstrated a functional capstan drive achieving a torque amplification ratio of 8.6:1, with the 9 mm sleeve outperforming the 15 mm sleeve as predicted by theory. Identified PLA sleeve wear, not the Dyneema cord, as the limiting factor in positional drift after 5,000 cycles, providing a concrete basis for the next development phase.







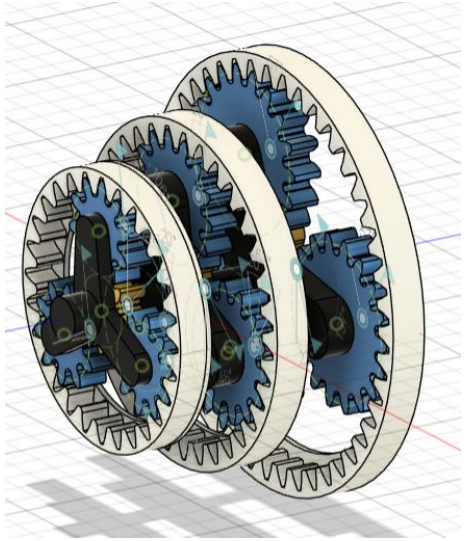
Svante

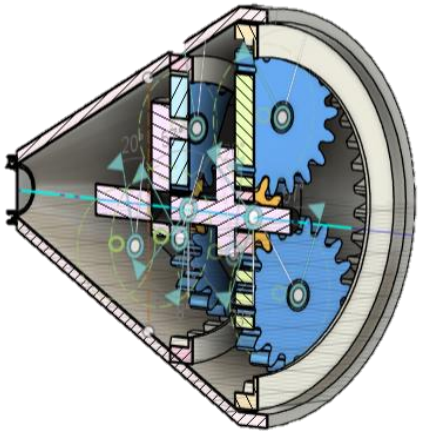
Fixture for Holding Product In-situ Conditions

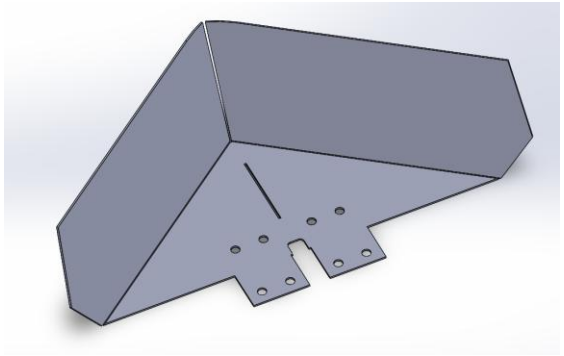
- **Situation:**
  Product testing required maintaining specific positional and environmental conditions to simulate real-world operation.
- **Task:**
  Design a fixture capable of securely holding parts during in-situ mechanical and thermal testing.
- **Action:**
  Designed a modular holding fixture in **Creo**; ensured material compatibility with test environment; coordinated fabrication and integrated with test equipment.
- **Result:**
  Enabled realistic testing scenarios, improving data accuracy and accelerating product validation.

Carbon-Neutral Streetlight

- **Situation:**
  UBC Smart City team developing a modular wind turbine system that can be retrofitted onto existing streetlights to enable carbon-neutral energy generation.
- **Task:**
  Design an efficient mechanical system to convert low turbine RPM into usable generator speed while ensuring manufacturability and system integration.
- **Action:**
  - **Designed** a 3-stage planetary gearbox to achieve required speed multiplication from low RPM input
  - **3D printed** and **tested** prototypes to validate gear meshing, torque transmission, and system efficiency
  - Designed **sheet metal** wind turbine blades in SolidWorks, then **waterjet cut** and performed **bending operations** to fabricate functional prototypes
- **Result:**
  - Successfully validated gear meshing and speed amplification, while identifying torque transmission limitations under real conditions
  - Delivered a fully fabricated proof-of-concept system







Svante

Brackets and Upgrades made to Test Bench

- **Situation:**
  The testing bench setup lacked rigidity, causing vibration and measurement errors during validation.
- **Task:**
  Improve bench stability and accuracy for test repeatability.
- **Action:**
  Designed new support brackets and reinforcements in **Creo**; made the bench **modular** using off the shelf parts; and validated upgrades by repeated testing and data analysis; **automated data analysis** for report using VBA in excel
- **Result:**
  Improved fixture stiffness and reduced error margins, leading to more reliable test data and smoother operations.