



# Team Mountain Arm Interdisciplinary Senior Project



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## PROBLEM



Navy veteran Cassie Perando (QL+ challenger) needs a way to backpack comfortably and independently while wearing a transhumeral prosthesis because her current prosthesis gets caught and uncomfortably pinches when wearing with a backpack.

## OBJECTIVE

- Design and develop a transhumeral prosthesis that Cassie can use comfortably while backpacking.
- Develop a secondary attachment system to properly distribute the weight of the prosthesis



## ENGINEERING SPECIFICATIONS

| Parameter Description                      | Target or Requirement | Tolerance    |
|--|-----------------------|--------------|
| Price                                      | 5,000 USD             | Max          |
| Shoulder Lateral Range of Motion           | 90 Degrees            | Min          |
| Range of motion of elbow                   | 120 Degrees           | Min          |
| Distance from Backpack Strap to Prosthesis | 0.25 inches           | Min          |
| Forearm Length (Olecranon to Styloid)      | 9.25 inches           | ±0.25 inches |
| Forearm Circumference                      | 9.5 inches            | Max          |
| Wrist Circumference                        | 6 inches              | Max          |
| GIH Joint (shoulder) to Elbow              | 13.5 inches           | ± 0.5 inches |
| Force to Accidentally Remove Device        | 25 lbs                | Min          |
| Corrosion Rate                             | 0.02 mm/year          | Max          |
| Temperature Operating Range                | 20 to 120 °F          | Min, Max     |
| Weight (without terminal device)           | 5 lbs                 | Max          |

## DESIGN: PROSTHESIS



- The prosthesis socket shape was modeled to her dimensions using 3D scans of Cassie's residual limb and current prosthesis in order to create an ideal fit.
- Straps with a BOA ratcheting system were incorporated with a dynamic socket to allow for adjustments to achieve maximum comfort.
- A Pin and Lock primary attachment system was chosen because it utilizes a comfortable liner and requires less secondary attachment that would get in the way of backpacking straps.

## DESIGN: SECONDARY SUSPENSION



The sports bra allows the force from the arm to be spread over a larger surface area. A strap connects the prosthesis to the bra with velcro. The strap is then able to be tightened down for an ideal fit. This secondary suspension is intended for extra support, but is not what primarily keeps the prosthesis attached to the arm.

## CHALLENGES



- Cassie lives in Oregon while the team lives in California, this made the entire design process challenging.
- Amidst COVID-19 the team had to be adaptable — Conner would take parts home to work on and drive them back to SLO while Amanda would sew at home in SLO.

## MANUFACTURING

- Manufacturing the outer socket of the prosthesis required some ingenuity due to COVID shutting down Cal Poly's shops.
- Carbon fiber layup was done by use of a FoodSaver® vacuum bagging process.
- Alterations to the sports bra attachment were performed using a sewing machine.



## TESTING

- Much of the planned testing was to be done on Cassie. However, due to COVID-19, many of these tests have been delayed.
- The weight requirement was to be less than 7lbs. Total weight without terminal device (~0.25 lbs) comes to 2.58 lbs, which is well below our max weight spec.
- The dimensions of the prosthesis are based on measurements done on Cassie.



## CONCLUSION AND RECOMMENDATIONS

- The final design is adjustable, lightweight and custom designed around Cassie's geometry to optimize comfort and minimize interference with backpack straps.
- Final Testing of the prosthesis has been delayed due to COVID-19. Therefore, any final adjustments to forearm assembly and cable system integration has been delayed.



## Acknowledgments

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