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**Sponsor:** Quality of Life Plus (QL+)

## Problem Statement

Our goal was to design and manufacture a prosthetic leg specifically for surfing to be used by Dana Cummings, a veteran amputee who lives in Pismo Beach. The foot had to be designed so that Dana would not slip when standing to catch a wave.



Current Leg

As Dana leans back to stand up, his foot slips due to the edge on his foot.

## Dana Cummings

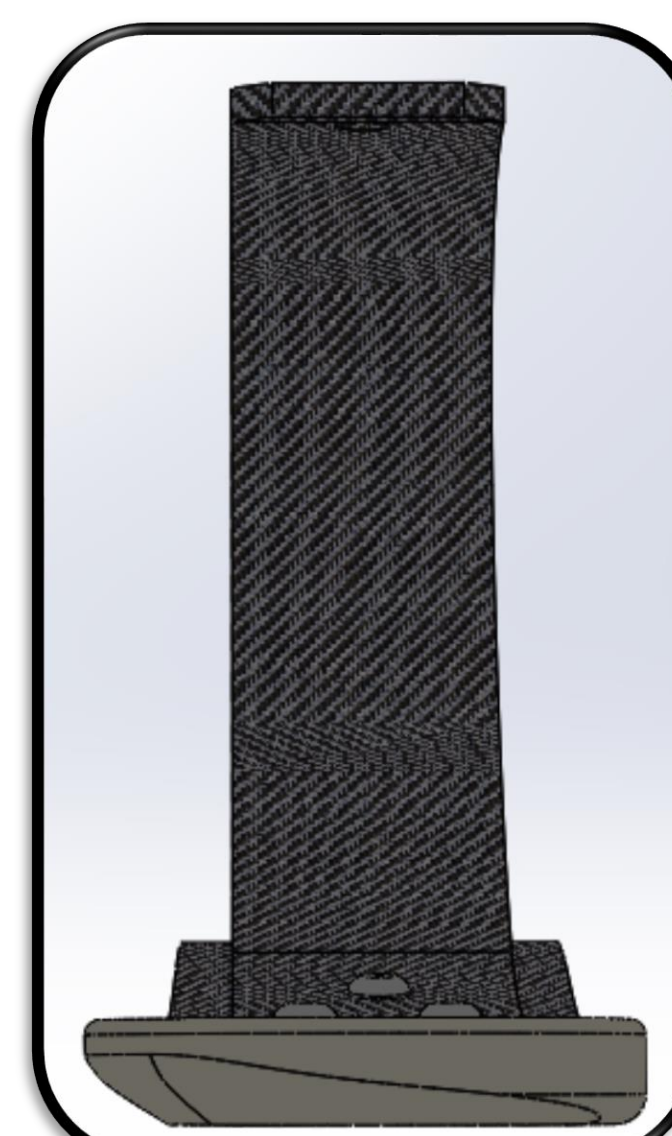
Dana is a transtibial (below-the-knee) amputee and a U.S. Marine Corps veteran. He competes in surfing competitions for amputees around the world. He also founded AmpSurf, an organization established to promote, inspire, educate and rehabilitate through the healing power of the ocean and adaptive surfing.



## Engineering Specifications

Spec #	Parameter Description	Requirement or Target	Tolerance
1	Coefficient of Friction	0.65	± 0.3
2	Height	7.5 in	± 0.05
3	Surface Area of Foot	31.5 in <sup>2</sup>	± 2.5
4	Drag While Paddling	2 lbf	MAX
5	Weight	3 lbs	± 0.5

## Final Design



Front View

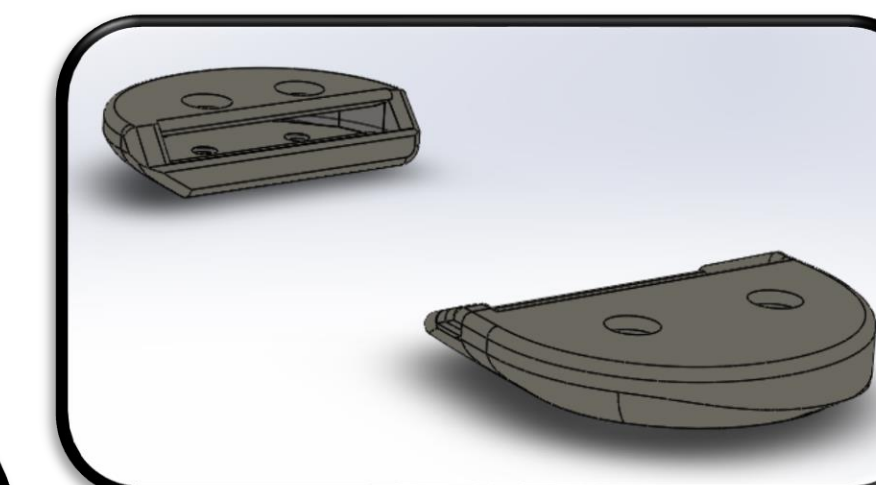


Exploded View



Assembly

### Rubber Components



Polyurethane  
Shore Hardness - 60A

### Pylon and Foot

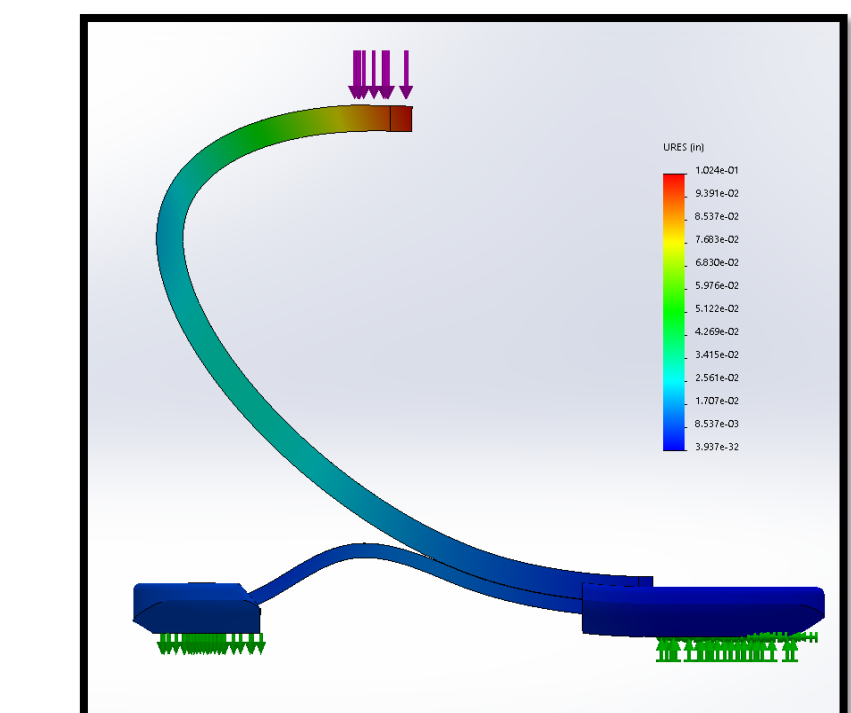
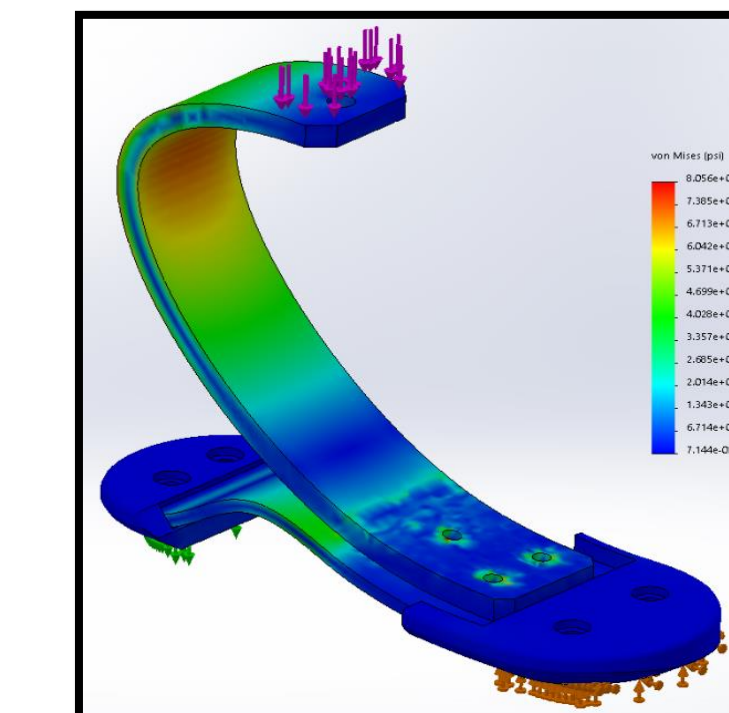


Unidirectional Carbon  
Fiber Epoxy Layup

## Finite Element Analysis

### Case 1:

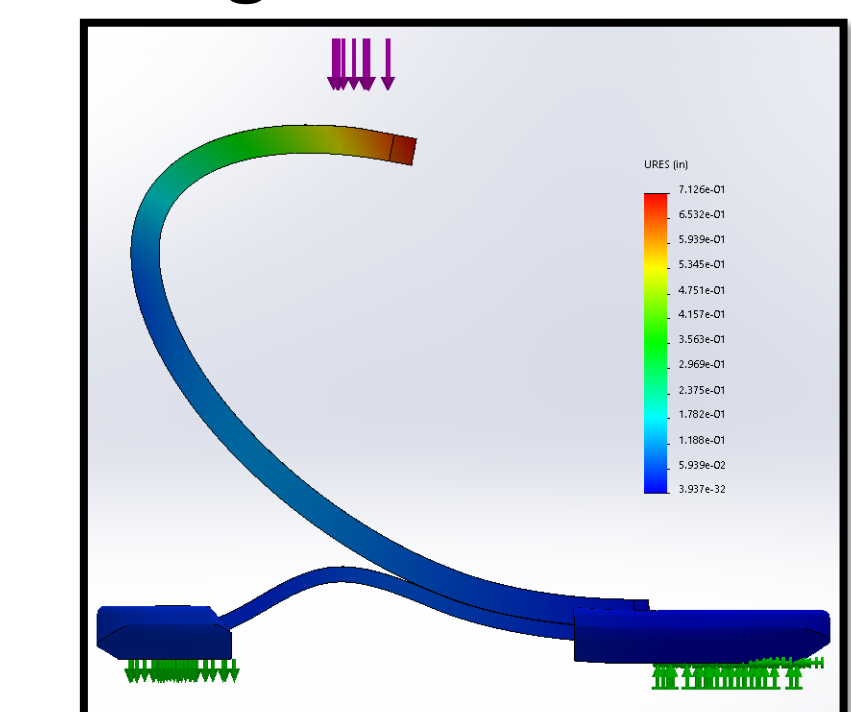
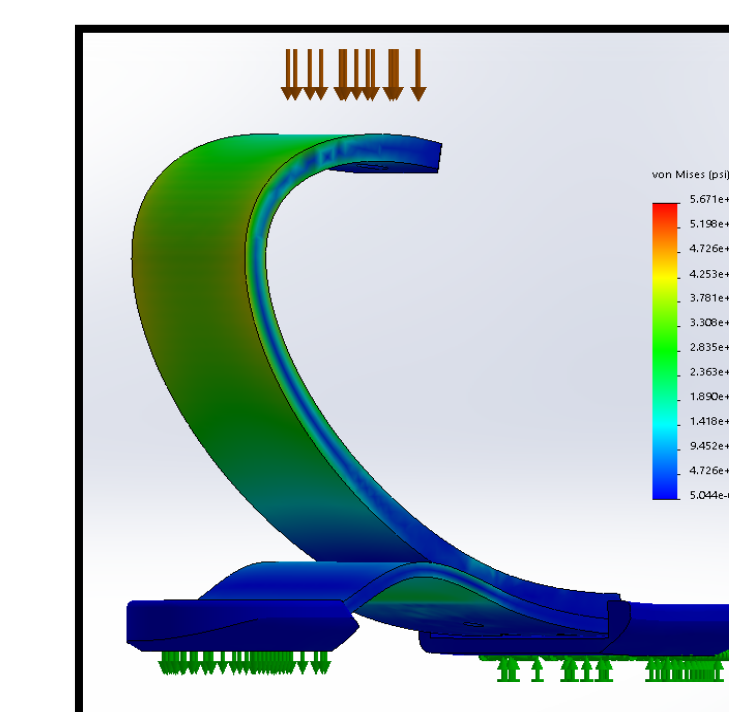
100 lbs loaded where pylon connects to pyramid adapter. This simulates Dana standing as he normally would on his surfboard.



Max Stress – 8.06 ksi  
Allowable Stress – 500 ksi  
Max Deflection – 0.10 in

### Case 2:

600 lbs loaded where pylon connects to pyramid adapter. This simulates 3x Dana's weight to ensure the foot will not break when he applies a larger force to stand.

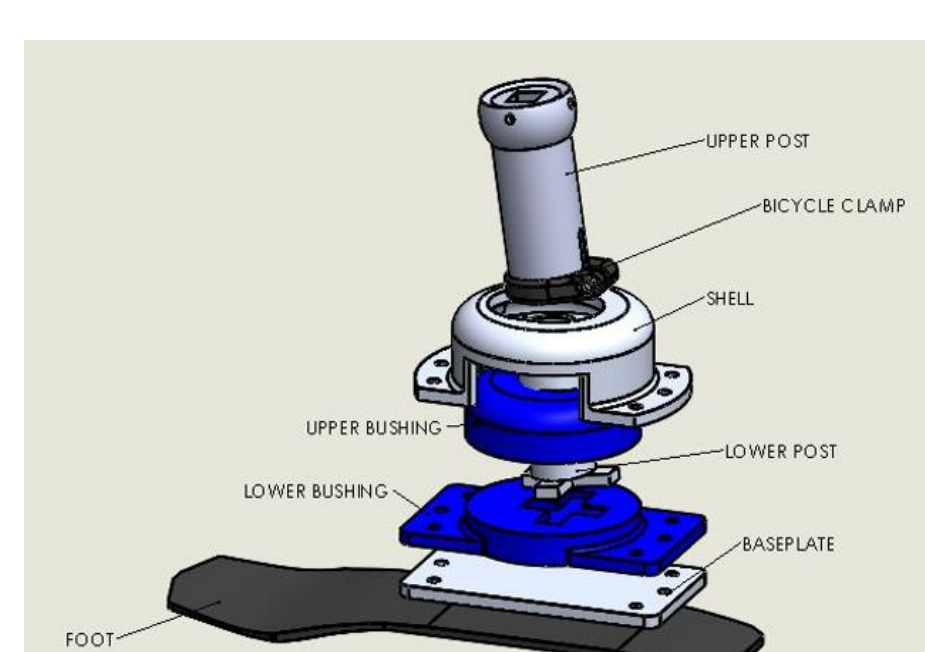


Max Stress – 56.7 ksi  
Allowable Stress – 500 ksi  
Max Deflection – 0.71 in

## Previous Products



Rush Foot Rouge, available for purchase



Cal Poly Senior Project, 2019

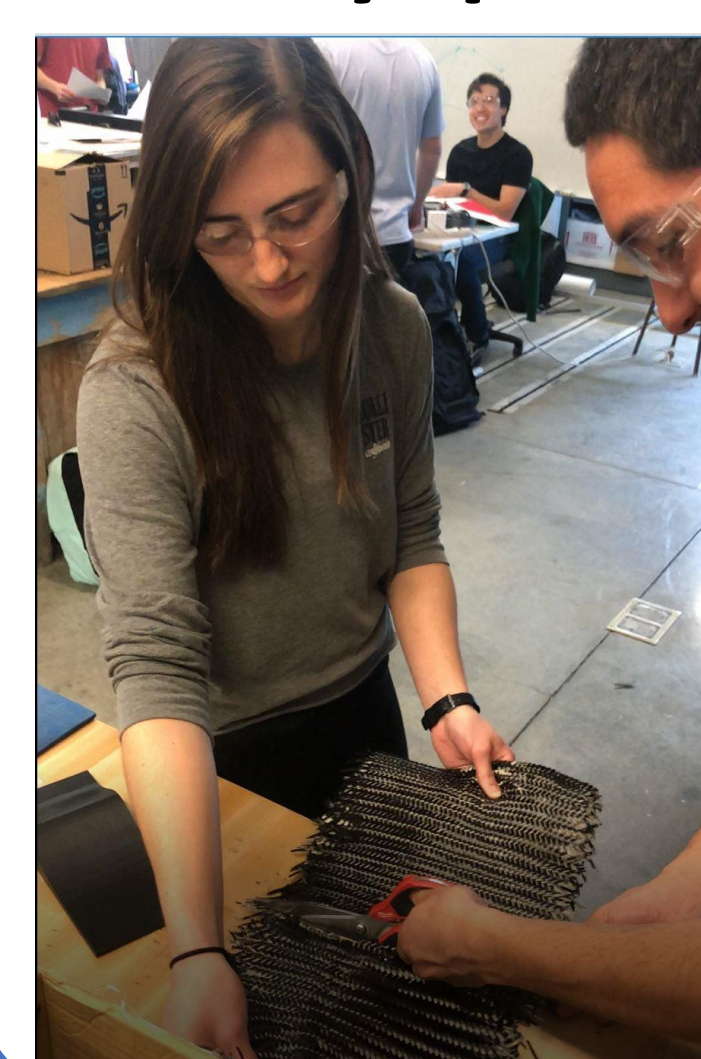


Unmodified leg Dana currently has

None of these designs address Dana's slipping issue.

## Manufacturing

### Carbon Fiber Layup



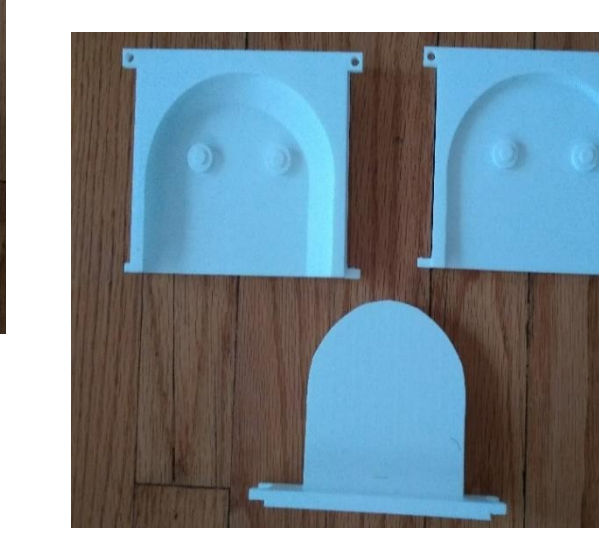
### 3D Printed Molds



Pylon Mold



Foot Mold



Front Rubber Mold

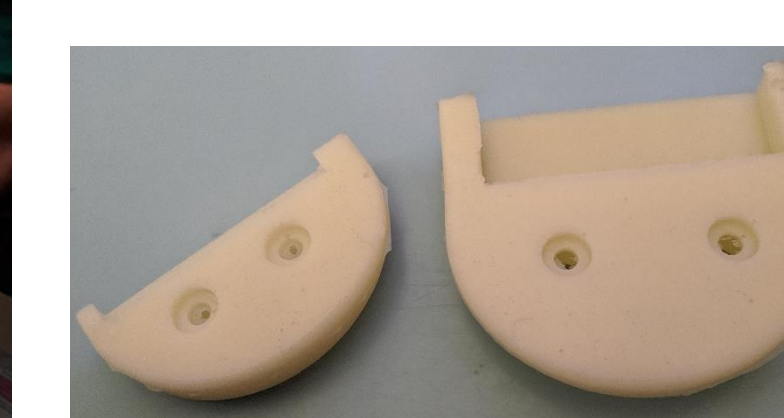
### Rubber Sleeve Molding



### Rubber Sleeves



Curved Edge View



Final Sleeves

## Future Steps

- Manufacture carbon fiber components
- Assemble prosthetic using all key components
- Perform the following testing to evaluate the mechanical properties of the prosthetic:
  - Compression Test
  - Submersion Test
  - Drag Test
- Analyze the data from the test results to evaluate the safety and effectiveness of the device
- Once the safety and efficacy of the prosthetic are confirmed, deliver prosthetic to Dana for testing and personal use

Note: Due to the closure of campus facilities as a result of the COVID-19 pandemic, we were unable to manufacture the carbon fiber components of this project. As such, it is unclear when the prosthetic will be completed.