

# EVA ASTRONAUT GLOVE x BIOMIMICRY

TRENTON JONES -- TMJONES@ASU.EDU  
COLLINS/Vizproto-ART494/598/ Digital Culture/Spring2016

## Abstract

In this study, the methodology of biomimicry was used to optimize EVA glove pads and finger-caps to enhance an astronaut's grip. A literature review of octopus suckers and their function for aid of 3D design replication was completed. The software application Rhinoceros 3D was used to create a 3D model and the 3D printed positive casting mold. Future research will focus upon testing suction abilities of the silicone sucker pads in a vacuum box, potential alternative materials, and glove integration.

## Research Question

How can biomimicry improve EVA gloves in the aid of astronaut's grip and grasp while performing maintenance outside the spacecraft?

## Precedents and Prior Research

+ In the past, astronauts' gloves used various synthetic and natural materials. Inspired by a Russian Cosmonaut glove made with shark skin pads, investigation into animals with superior gripping abilities was performed. This investigation lead to bio-adhesive studies of octopus suckers.

+ Better grip would allow astronauts to secure their position during maintenance and other type tasks while outside the spacecraft. Over time, in a pressurized suit, astronauts can lose full hand function and have to end extravehicular activity for safety reasons. These pads have the potential to extend extravehicular activities by removing certain stresses on astronauts' hands.

+ This project relates to my discipline of Industrial Design because of the growth in privatized space travel.

## Process

Literature Research > Sketching > CAD creation in Rhino3D & Solidworks > 3D printing on Z-Corp > Sealing the 3D print > Silicon Casting of 3D Print

## References

Gorb, Stanislav, Nick Aldred, and Romana Santos. Biological and Biomimetic Adhesives: Challenges and Opportunities. Royal Society of Chemistry, 2013. Google Books.

Gorb, S. N. "Structural Design and Biomechanics of Friction-Based Releasable Attachment Devices in Insects." Integrative and Comparative Biology 42.6 (2002): 1127-139. Web.

NASA. Space Suit Evolution From Custom Tailored To Off-The-Rack. <http://history.nasa.gov/spacesuits.pdf>. 28 Apr. 2016.

## Results

The 3D model of a test pad was printed on the Z Corp. However, due to the size and frailty of the Z Corp printing material, some of the pods did break off during excavation causing the in the silicone to fill in areas where pods were absent, as seen below.

## Conclusion

The silicone cast was a success! This concept has the potential to be applied to different areas of the EVA suit & its components. However, the feasibility of silicone material breakdown in the vacuum of space needs further investigation. Looking forward, revisions to the 3D model and printing device will continue.

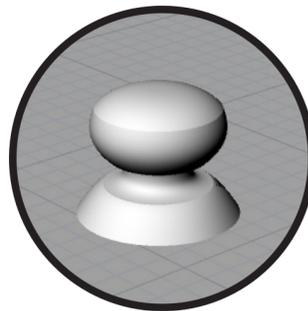
## Acknowledgments

I would like to thank Dan Collins, Mom & Dad, Kendra Enriquez & Mother Nature!

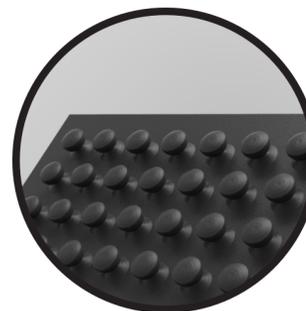
Cross-section of Sucker



Rhino 3D Model



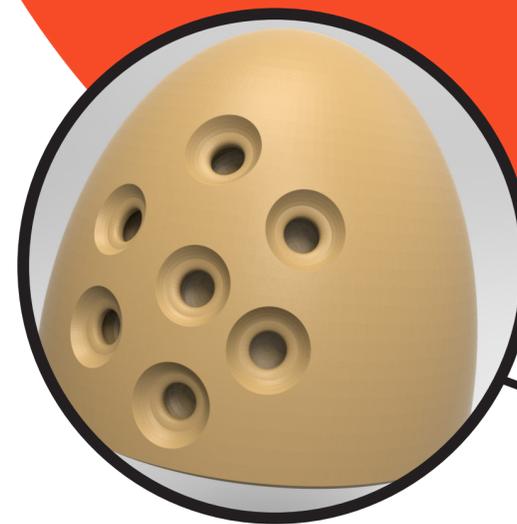
3D Printed Test Pad



Silicone Casting of Test Pad



3D Model of Finger-Cap



## What is biomimicry?

"Biomimicry is an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. The goal is to create products, processes, and policies—new ways of living—that are well-adapted to life on earth over the long haul."

- Biomimicry.org

## What is an EVA Suit?

EVA stands for Extravehicular Activity. This suit is a multi-layered pressurized space suit commonly used by astronauts during exterior repairs to the International Space Station.

## How does it work?

The EVA Suit is inflated to protect the astronaut from the harsh elements of space. According to NASA, "The pressure garment is operational at differential pressures of 3.70 to 3.90 pounds per square inch; In temperatures of -290 to +310 degrees Fahrenheit for Apollo missions . . . The pressure garment permits low torque body movements for operating spacecraft controls and specially designed devices required for space exploration or traversing the lunar surface."