Affordable Soft Robotics: Leveraging 3D Printing for Efficient Design

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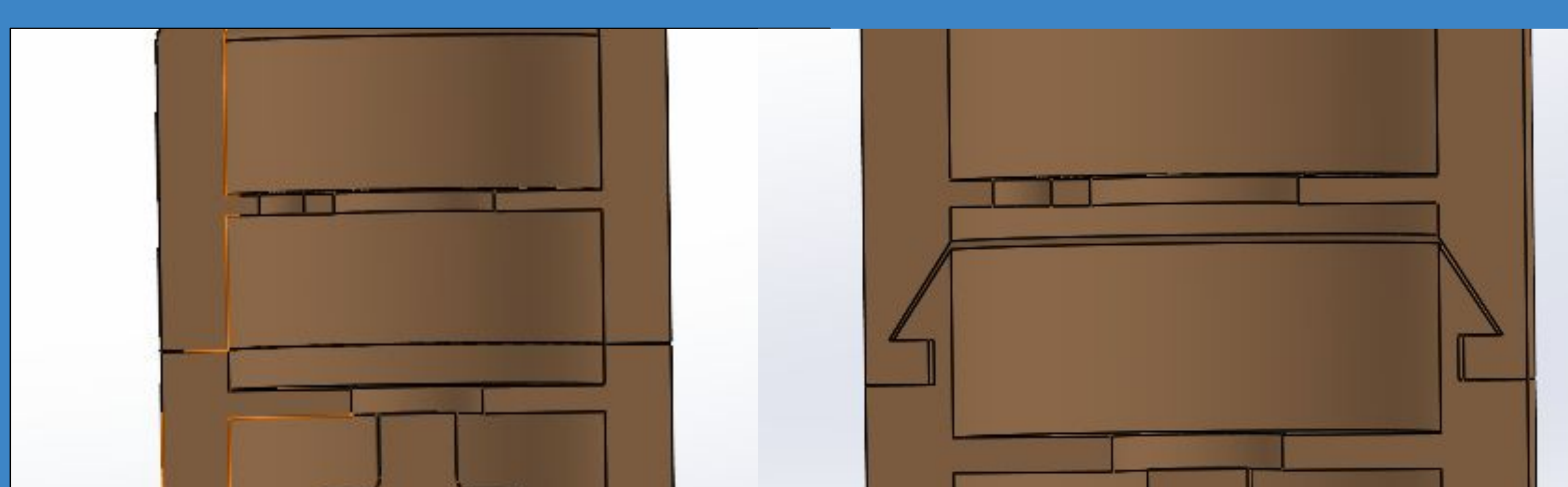
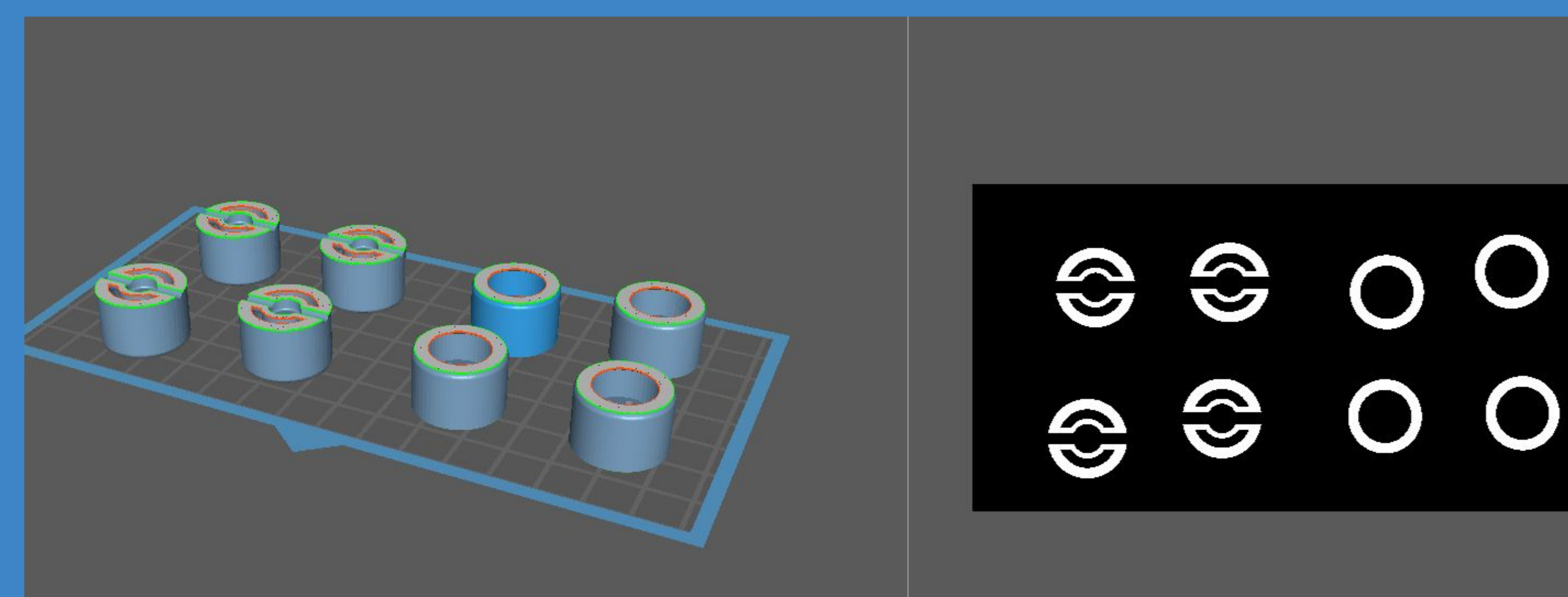
Introduction:

While soft robots offer several advantages—especially when it comes to safe interaction with humans—managing the fluidic systems that power them remains a significant challenge. Recently, Sochol's "Bioinspired Advanced Manufacturing (BAM)" Lab developed a method to 3D print soft robots with fully integrated fluidic circuits in a single printing process. They showcased this by creating a soft robotic hand that successfully played the first level of *Super Mario Bros.* However, their method relied on a high-cost 3D printer (over $100,000). I have been assisting a team with their ongoing research whose aim is to adapt that approach for use with low-cost 3D printers (under $500). My role was to assist in redesigning the transistor to be easier to assemble as-well-as working lab hours to clean off the printed parts and prepare them for testing to see how the change effects its functionality.





Materials & Methods:

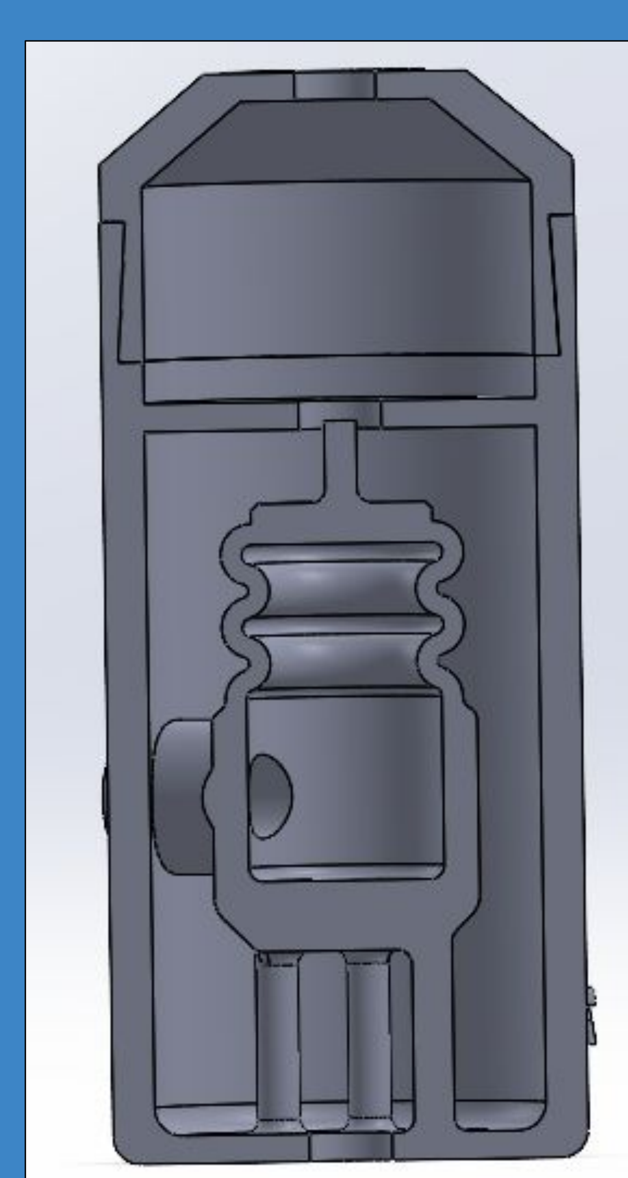
The iterations to the transistor were designed using the computer-aided design software SolidWorks where we aimed the transistor to be put together through additive assembly. In order to achieve this a design change was made allowing the cap of the transistor to come flush with the base structure in a hooked joint style although a different design was picked. After designed, the individual parts were exported into the Chitubox software for slicing before the printing process in the Mars 4 LCD 3D printer using F80 Elastic Resin.

The post-processing began with soaking the printed parts in isopropyl alcohol (IPA) and removing them from the build plate by hand. Once removed they were placed in conical tubes with more IPA and shaken to wash excess resin still on the parts. Furthermore, syringes were filled with IPA and used to flush out remaining resin still within the base structure. Once clean the free-floating disk was placed on top of the base structure before the cap structure would be placed on top and sealed using q-tips to apply resin to the dovetail structure and solidified using the Mercury XS post curing station. Finally, a strong adhesive glue was applied to the top, bottom, and side of the fluidic transistor in order to attach Lure barbs necessary for testing.

Testing was done using the Fluigent FlowEZ microfluidic pressure control system and the OxyGEN software. Water was used for P_{Source} input and air was used for the P_{Gate} input. To determine when the transistor would be closed, the P_{Source} was varied until a sealing pressure was discovered.

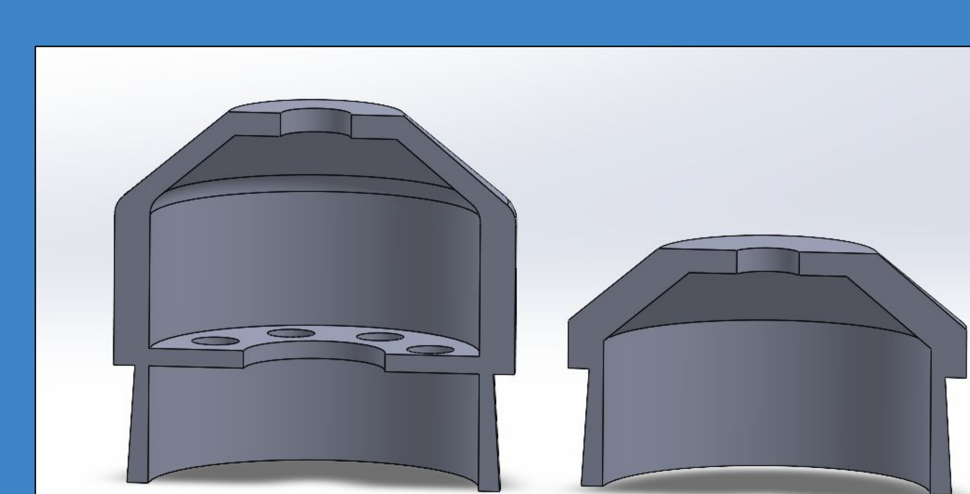
Results:

In the time I have been a part of this I have been unable to get any results regarding sealing pressure; however, as this has been an ongoing study, there has been results gathered by my peers from working models that shows the transistor has potential. Furthermore, in my time (though specific values were not collected) one assembled transistor did seal properly during testing filling me with hope as I continue to assist in this research.



Discussion:

Though not on the team for very long I am proud of the contributions I was able to make and the skills I was able to pick up working with experienced individuals for the last few months. Moving forward I have also made iterations to the cap design in order to produce a normally open transistor (NOT) using a similar base structure that will seal the P_{Source} flow at given P_{Gate} pressures acting inversely to this iteration of a transistor.



Site Information:

Location: Bioinspired Advanced Manufacturing Laboratory

URL: https://bam.umd.edu/

Address: Glenn L. Martin Hall, Building 088 University of Maryland College Park, MD 20742

Site Contact: rsochol@umd.edu or call (301)-405-6928

Supervisor: Muhaymin Chowdhury

Site Objective: Advance the life sciences and biomedical applications of 3D printing on a micro/nanoscale.

Goal of my Site: Controlling fluidics in soft robots using parts printed from inexpensive 3D printers

Acknowledgments:

Thank you to the University of Maryland's Vertically Integrated Projects (VIPS), and my phenomenal team of peers for welcoming me to assist in their research as well as Dr. Holtz and Dr. Merck for my experience in SGC.