Iliac Bifurcation Aneurysm Model

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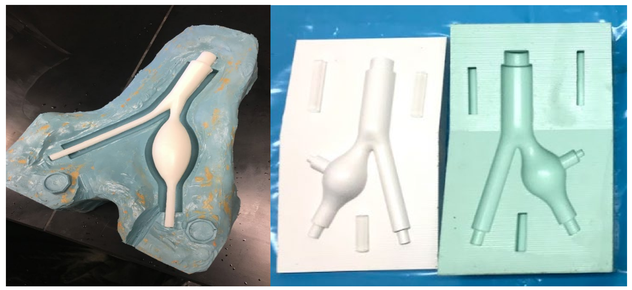
Manufacturing Process

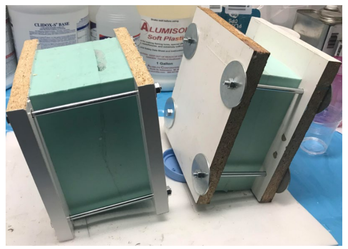
Through research and personal experience the lost wax method was chosen for producing models. This process is commonly used in massive produced artwork ranging from ceramic to copper creations. A manufacturing process was developed in the first semester for prototyping and through iterations the process was refined to eliminate possible casting faults. Some of the second semester revisions are as follows:

Patterns



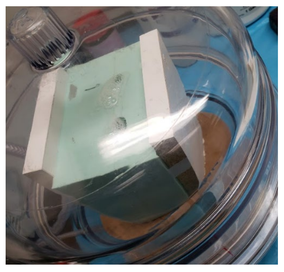
Mold clamps

- Short shots occurred in 2 casts improper clamping was determined as the cause. Torque wrench did not have desired resolution. Threads were counted to ensure pressure distribution and bolts were hand tightened in a star pattern.



Degassing the molds

- Though the liquid polyurethane was degassed it was decided that the entire mold would be put in the chamber to continue removing air from the system. This was done for 5-minutes in 2.5-minute intervals.



60 shore A molds

- Mold deformation was a concern for the softer silicone. Second semester a 60 shore A was purchased to address this issue. More benefits were discovered by other teammates in using the harder material.

Pulse Wave Propagation Test

Initially a continuous flow pump was chosen for the project to simply meet the project requirements. The team decided to experiment with a speed controller and learned that the pump could be controlled to simulate a pulsatile flow. Taking this information the team developed a program to have the pump produce an anatomical flow wave form from research [1]. Tests were conducted to validate the waveform in semi ridged pipes using two pressure transducers (Figure 1). One transducer would be used as a static pressure collector and the other would be connected to a Pitot tube. The pressure needed to be collected in the same location due to transient flow (Figure 2). This data was used to calculate the flow rate of the wave in the system.

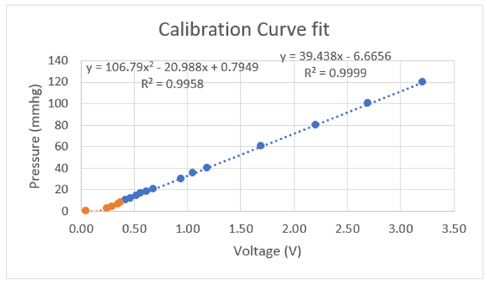
Equipment

- Deltran pressure transducers
- ½' clear vinyl tubing
- 2 Arduino mega
- HX-711 Wheatstone amps
- Pump and revisor bucket

Calibration

A Sphygmomanometer was used to calibrate the transducers as follows:

- Range 120 mmhg to 0 mmhg
- Nonlinear after 10 mmhg
- 18 total points collected
- 120-20 descend by 20 mmhg
- From 20 to 2 descend by 2 mmhg



Sphygmomanometer

Test

- Prime system with pump
- Initiate pulsatile flow
- Allow 30 sec of run time
- Collect data from serial monitor

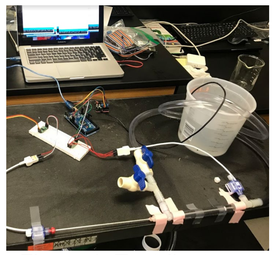


Figure 1: Test System

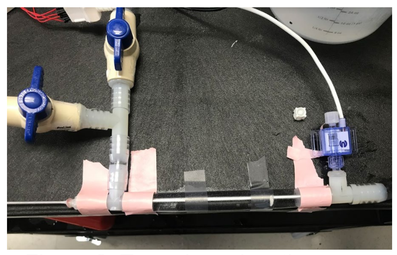


Figure 2: Transducer locations

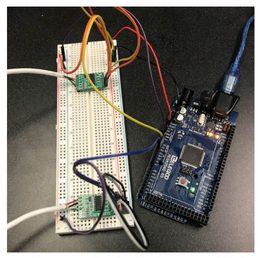


Figure 3: hx711 and Mega

Results

Uncertainty in the hx711 and in the pressure transducers were applied to the voltages collected for static and stagnation pressure, the calculated error was $\pm 20 \frac{\text{mV}}{\text{mmhg}}$. This error was plot with the anatomical data and the data collected from the experiment in figure 4.

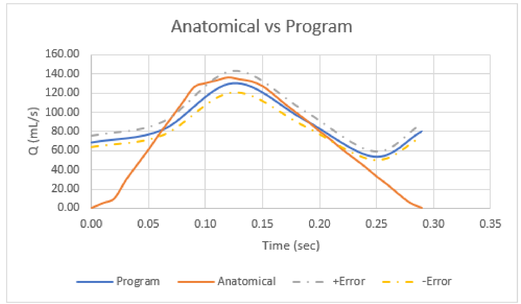


Figure 4: results of tests

The pulse wave that is propagated from the pump is not an exact fit. The anatomical wave data falls within the error of the system illustrated by the dashed lines in figure 4. The slopes of the ascending and descending wave do not match that of the desired wave and will need to be further investigated.

Concomitant data was calculated to further understand the similarities of the waves.

Pump Flow rate	
Max	161.75
Min	14.98
Avgerage	80.06
RMS	114.38
Integration	29.44

Anatomical flow rate	
Max	136
Min	0
Average	72
RMS	96.17
integration	21.48

Website

The website duties involved updating the website weekly. Learning HTML coding and reaching out to professors and departments that I would have not encountered otherwise. The most difficult part of the website was getting a truthful critique. My team was just happy that we had a working site and didn't want to criticize me. During second semester I asked several departmental professors their honest opinion about the website and was able to make positive changes.

References

[1] P. Reymond, Y. Bohraus, F. Perren, F. Lazeyras, and N. Stergiopulos, "Validation of a patient-specific one-dimensional model of the systemic arterial tree," *American Journal of Physiology-Heart and Circulatory Physiology,* vol. 301, no. 3, 2011.

Acknowledgments

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