in vitro Vascular Defect Modeling

Mechanical Engineering

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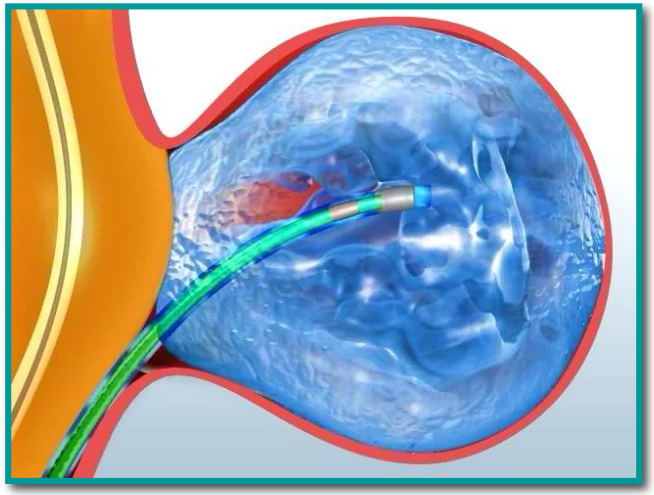
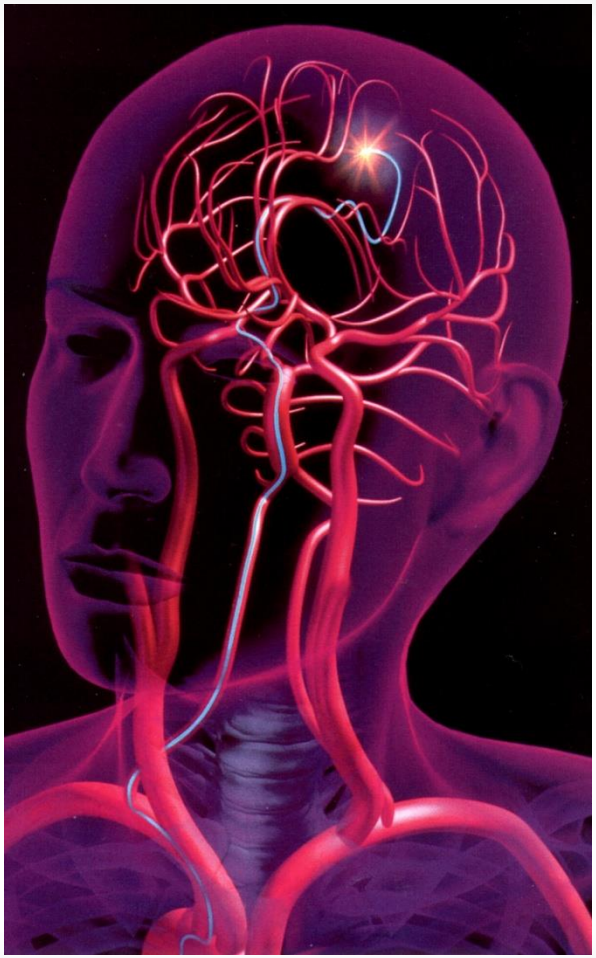
Agenda

- Introduction
- Project Description
- Engineering Requirements
- Considered Designs
- Chosen Design
- Manufacturing
- Moving Forward
- Conclusion
- Acknowledgements

Introduction

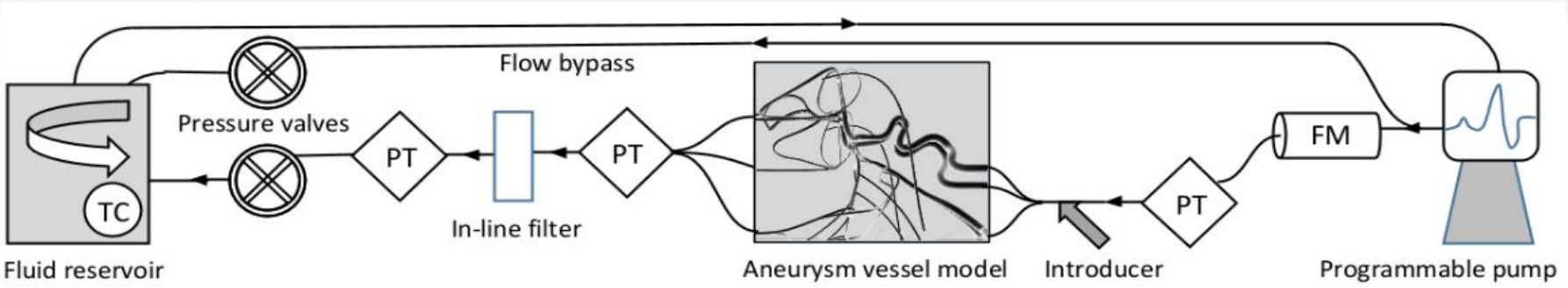
Dr. Becker's Bioengineering Devices Laboratory (BDL) is researching liquid embolics as a medical device for the minimally invasive treatment of blood vessel defects, such as hemorrhagic stroke and tumors





Introduction

Project Description



- *in vitro* model for aneurysm treatment via embolization
  - Create a novel vasculature system
  - Develop a more enhanced simulation of a biologic environment than the commercially available models
  - Reduce the need for animal testing

Requirements

Table 1: Engineering requirements of *in vitro* model

Engineering Requirements
Accuracy of anatomical measurements
Compliance of vessel material
Physiological accuracy of flows
Physiological accuracy of fluid
Transparency of vessel material
Accuracy of data acquisition
Accuracy of manufacturing processes
Size
Weight

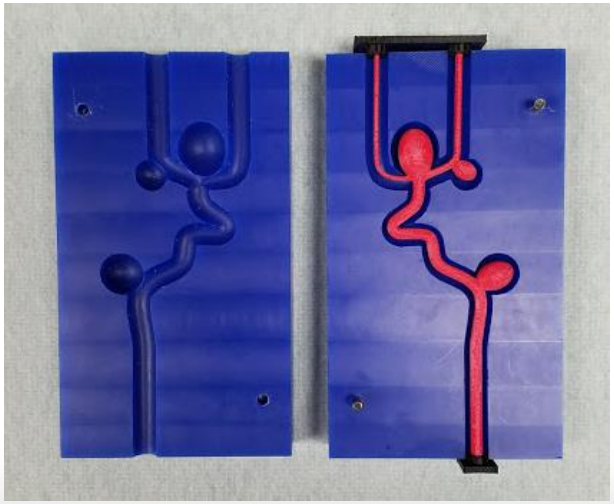
Designs Considered

Table 2: Considered design option for each sub system

Vasculature Material	Fluid	Pump	Casting Method
Silicone	DI H_2O	Sink	Outer cast with inner core
PAAM-Alg	CMC	Shelley Medical Programmable pump	Clear Flex 2-part mold
ClearFlex	Glycerol	Fischer Scientific pump	3D printed model

Chosen Design

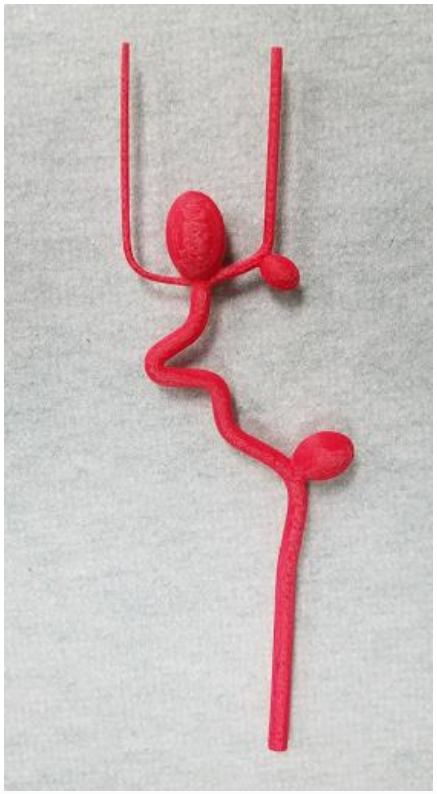
- The final design will include:
  - Machined outer wax mold
  - 3D printer inner core of vasculature
  - CMC fluid
  - PAAM-Alg vasculature material
  - Data Acquisition System (DAQ) for flow modeling
  - Fischer Scientific Pump



Manufacturing of Design

Machined outer mold

3D printed inner core



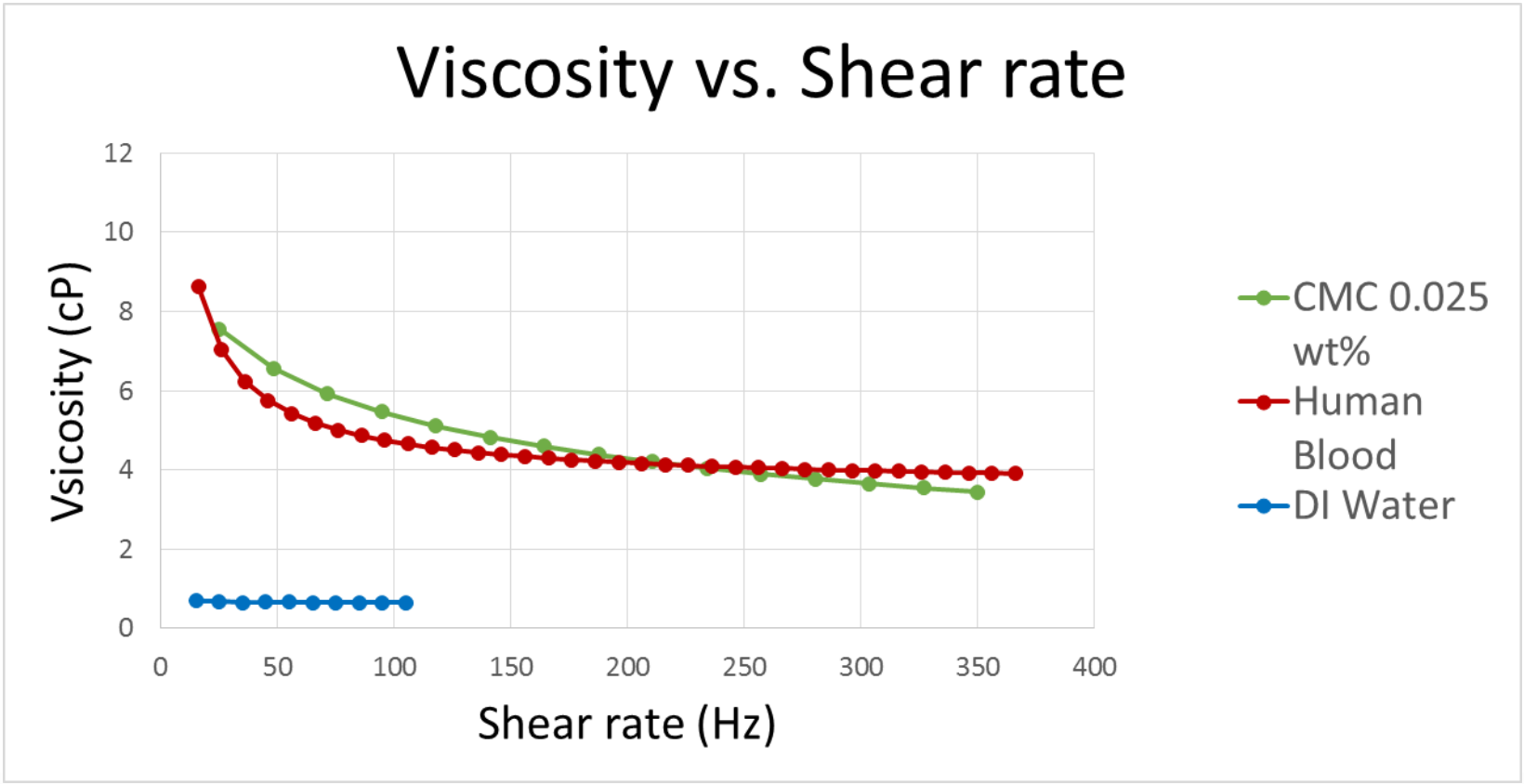
Manufacturing of Design

Casting Procedure:

1. Mix PAAM-Alg
2. Insert core into cast
3. Close cast around core
4. Insert bottom stabilizers
5. Pour in polymer
6. Insert top stabilizer
7. Allow material to cure
8. Take apart apparatus
9. Remove/dissolve core

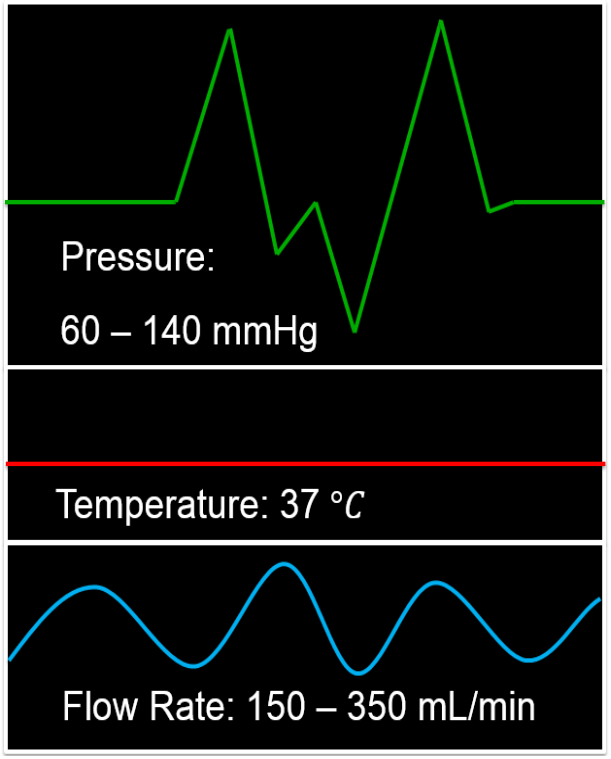
Manufacturing of Design

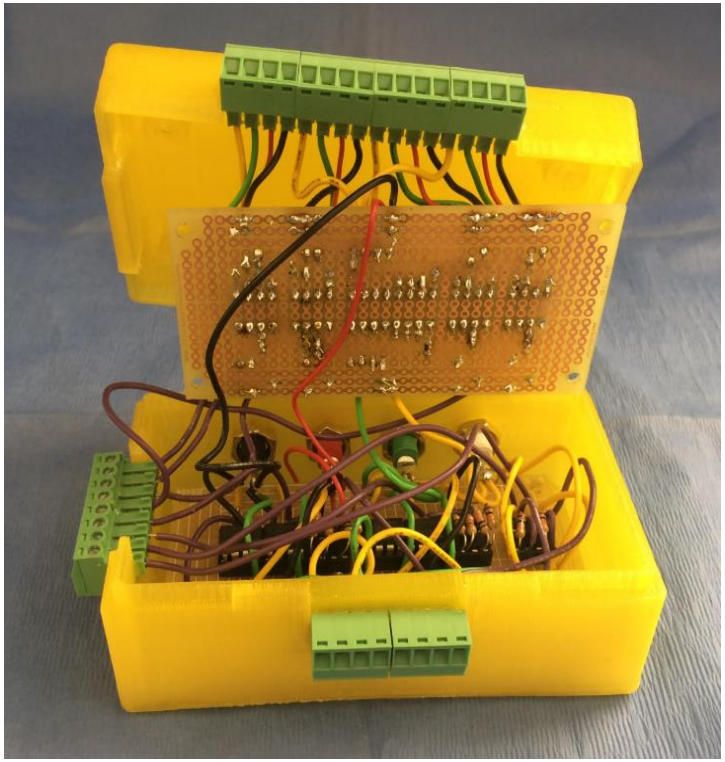
CMC fluid



Manufacturing of Design

Data Acquisition System (DAQ)

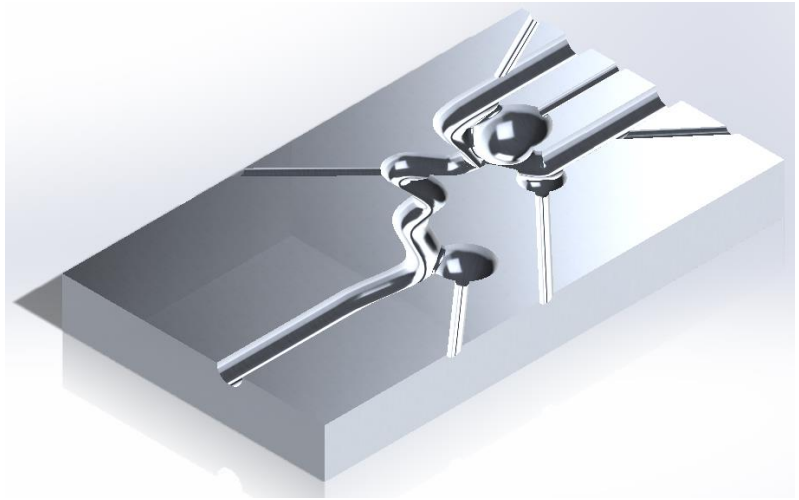


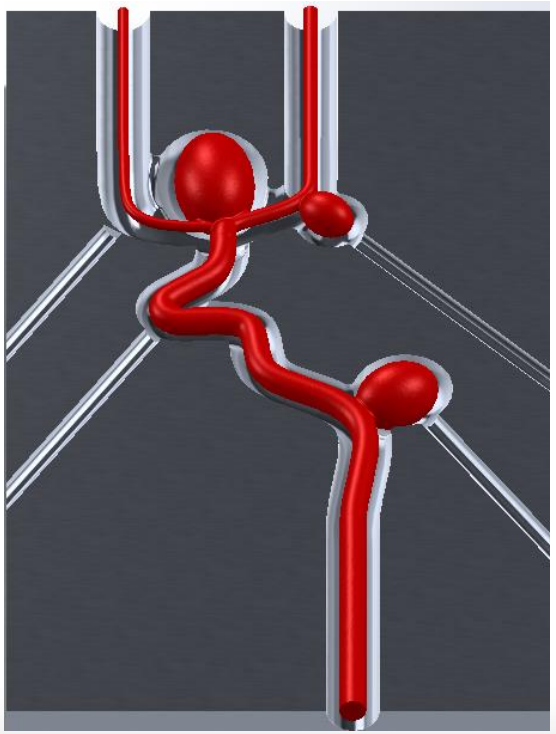


Complete Flow Model

Design Changes

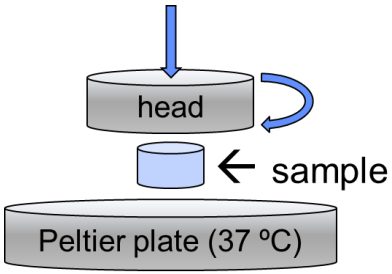
- Dissolve inner core instead of pulling core out
- Metal mold instead of wax mold
- Add air channels

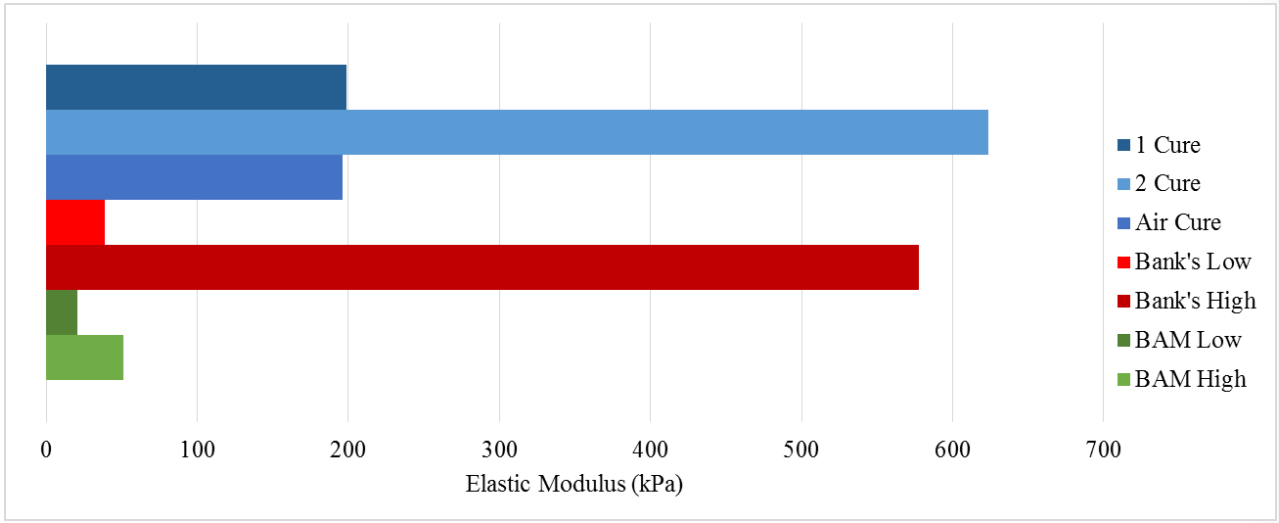




Model Testing

The vessel material was testing in comparison to biologic vessel data





Moving Forward

- More trials using PAAM-Alg
  - Perfect casting method
- Upgraded programmable pump
- Stainless steel CNC blocks
  - To ensure minimal reactivity

Conclusion

- Operating flow loop and measurement devices
- Blood-like fluid without sugar
- Completed proof of concept for casting PAAM-Alg
- Functioning ClearFlex model

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Questions?

Thank you!