# In-Vitro Neurovascular Cast System


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## Abstract


Current brain aneurysm treatments focus either on smaller aneurysms or consist of highly invasive surgery. Aneuvas Technologies Inc. (ATI) has developed an injectable liquid embolic which hardens upon activation. The treatment can fill close to 100% of the aneurysm volume effectively cutting off blood flow and stopping aneurysm growth. The treatment is still in the testing phase and is necessary for the treatment to be administered repeatedly to ensure safety. Testing needs to be performed quickly, and to aid in the number of tests that can be run, an in-vitro system was needed. The in-vitro design contains anatomically accurate vessel size, tortuosity, and overall complexity of the entire Circle of Willis. And features clear elastic materials that closely match the properties of blood vessels. The designed vessels are enclosed by a clear acrylic box filled with a clear hydrogel support material which closely mimics brain densities. When the model is fully assembled it will mimic the properties of the human brain, but in an in-vitro setting.


**Methods:** Drawing of the vessels were first generated using SolidWorks, first a 3D printed core was ordered to ensure anatomical correctness [1]. Next the vessels were ordered, without aneurysms to test the functionality with the flow system. To connect to the flow system, an acrylic box was designed and adapters were installed. The acrylic box was then filled with a “head gel” [2] and the vessels were connected and suspended in the gel. A final print was ordered with the aneurysms, and connected to the flow system. The vessels were all printed using a proprietary material created by ProtoLabs, and is called Digital Photopolymer [3].

## Engineering Requirements

Table 1 - Engineering Requirements

| Engineering Requirements | Units | Tolerances | Target Values |
|---|---|---|---|
| Friction (Pulling Force) | Newtons (N) | ±0.003N | 0.015N [5] |
| Clarity | 1 (Unclear)-10 (Clear) | ±2 | 9 |
| % Elongation | Percentage (%) | ±10% | 150% |
| Hardness | Shore Hardness scale (A) | ±5A | 35A |
| Contaminant Level | Percentage (%) | ±5% | 0% |
| Cost | US Dollars ($) | ±200 | $2000 |

## Friction Analysis

All materials considered were tested to find the friction coefficient between the microcatheter and the vessel walls. The friction was measured using a rheometer, following a modified ASTM D1894 testing standard [4].

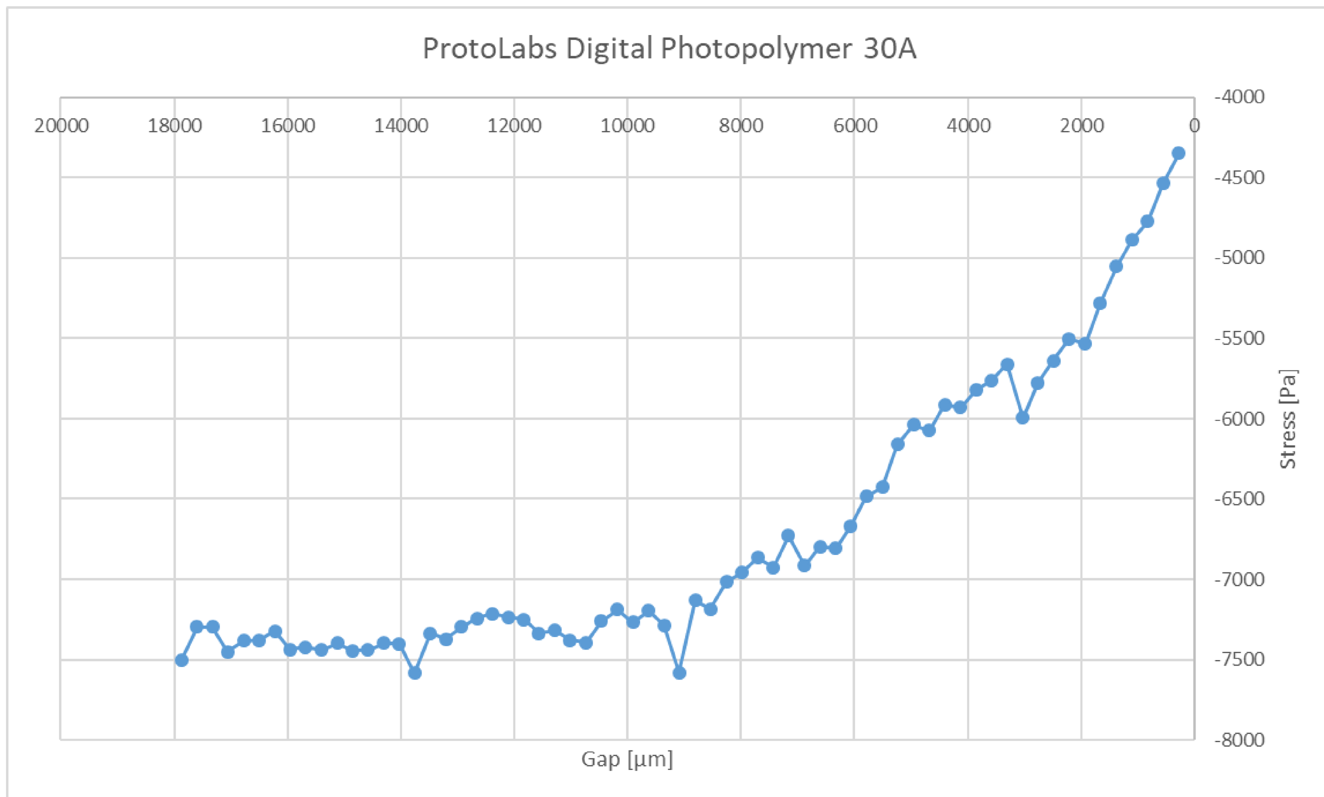


Figure 1 – Sample Friction Test Results

Figure 2 – Friction Test Set-up

Table 2 - Friction Analysis Results

| Material | Pulling Force [N] | SD |
|---|---|---|
| ProtoLabs 30A | 0.3294 | ±0.0412 |
| ProtoLabs 40A | 0.3351 | ±0.0470 |

Although the two potential ProtoLabs Materials have similar frictions, the material with a shore hardness of 30A is used. This material has a hardness closer to that of human blood vessels.

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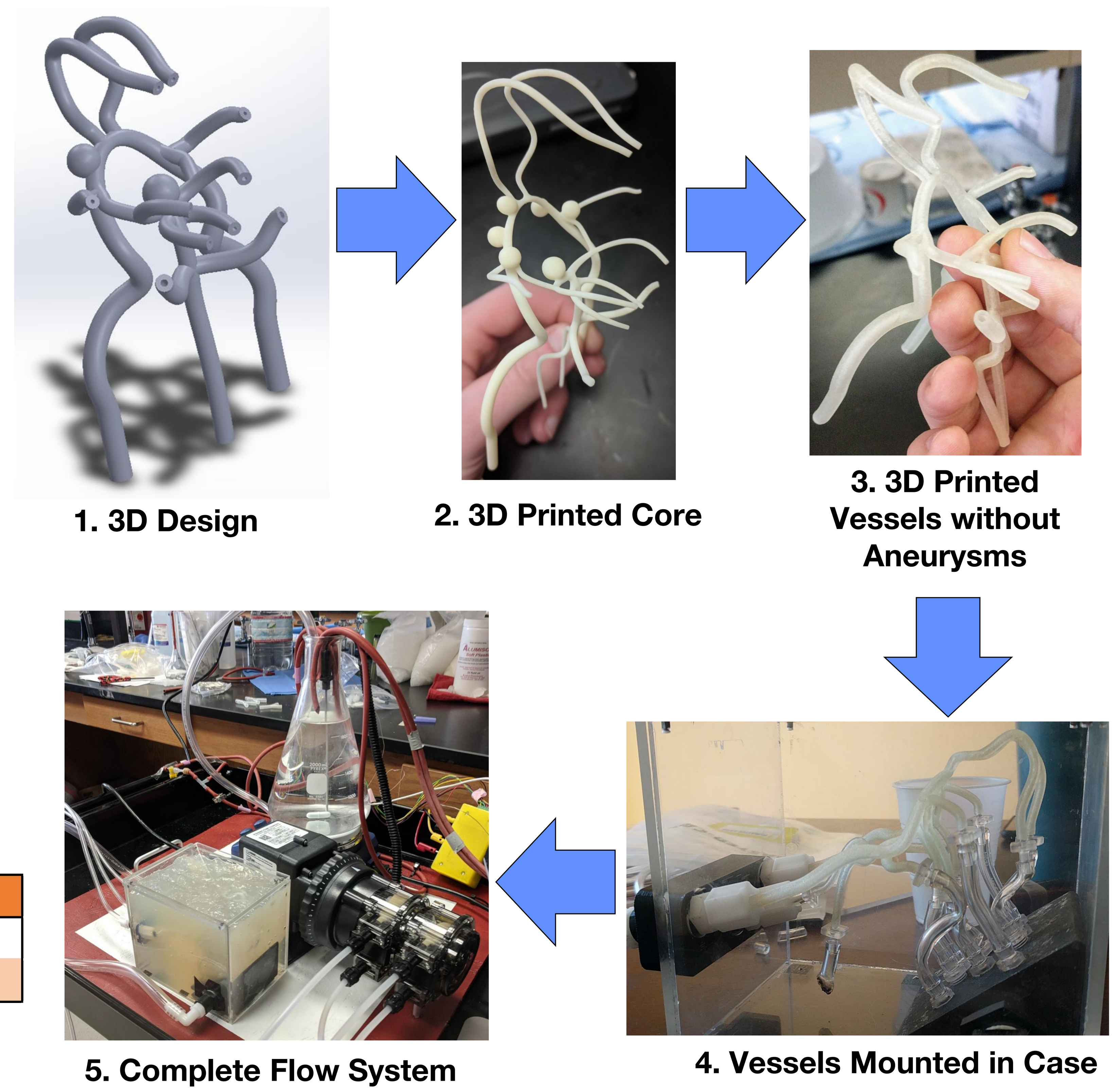
## Design/Manufacturing Process

The steps required to design and manufacture our system are shown in the flowchart below.




## References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[2]"Vascular Simulations – Custom Silicone Vessels, Mock Silicone Vessels, Endovascular Simulator, Silicone Arteries, Human Vascular Replicator", Vascularsimulations.com, 2018. [Online]. Available: http://www.vascularsimulations.com/Vessel/Filter?fid=28&page=1. [Accessed: 27- Mar- 2018]

[3]"Digital Photopolymer Product Specifications", *Protolabs.com*, 2018. [Online]. Available: https://www.protolabs.com/media/856667/polyjet-material-spec-data-sheet-02.pdf. [Accessed: 03- Feb- 2018]

[4]"ASTM International - Compass Login", Compass.astm.org, 2018. [Online]. Available: https://compass.astm.org/download/D1894.7150.pdf. [Accessed: 03- Nov- 2017]

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