BDL COMPACT VESSEL CLEANER (BDL CVC): CONCEPT EVALUATION

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Project Description

- Project Goal: To develop a pump system capable of cleaning 3D support material from vasculature models and improve In-vitro flow model conditions.
- Importance: In-vitro model is a necessary component of medical device testing in the BDL
- Sponsor: Dr. Tim Becker (NAU ME Faculty & BDL Principal Investigator)
- Mentor: Mana Alyami (NAU ME Graduate & Device Manufacturer at W.L. Gore©)

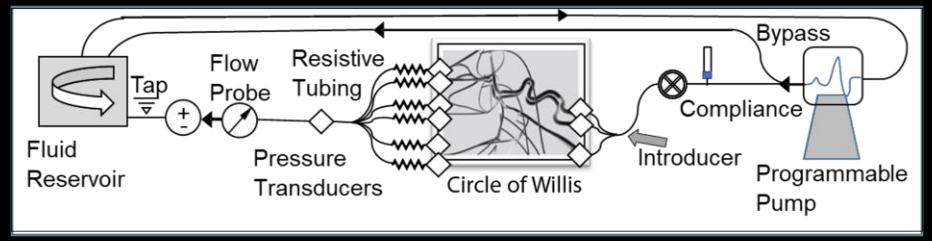

Figure 1: In-Vitro Flow Model Schematic

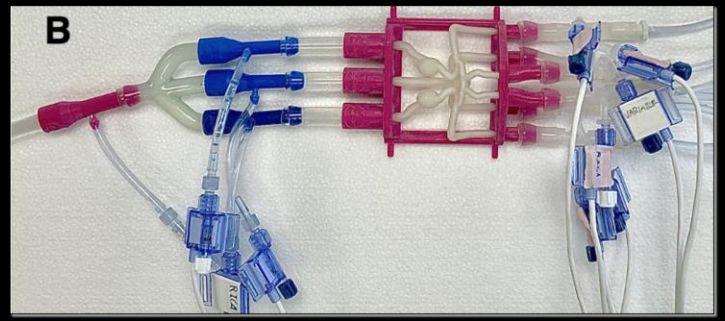

Figure 2: Circle of Willis Model

Black Box Model

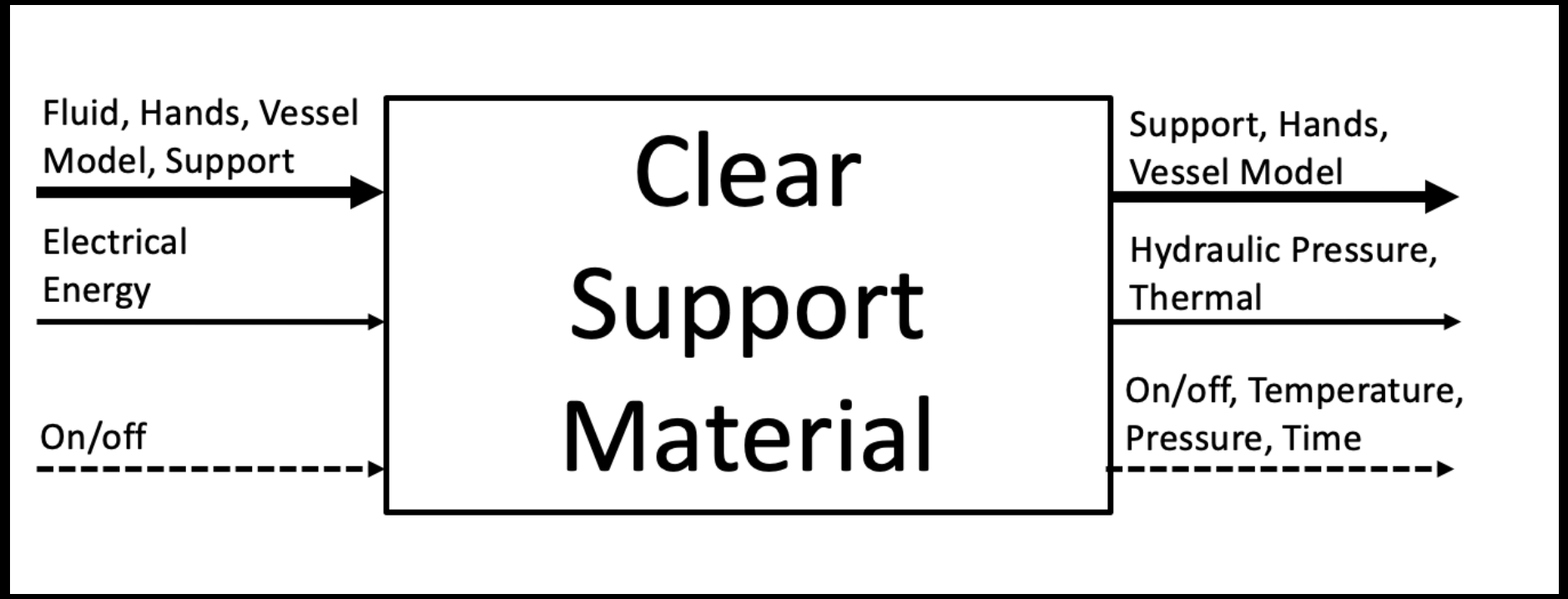

Figure 3: Black Box model

Functional Modeling

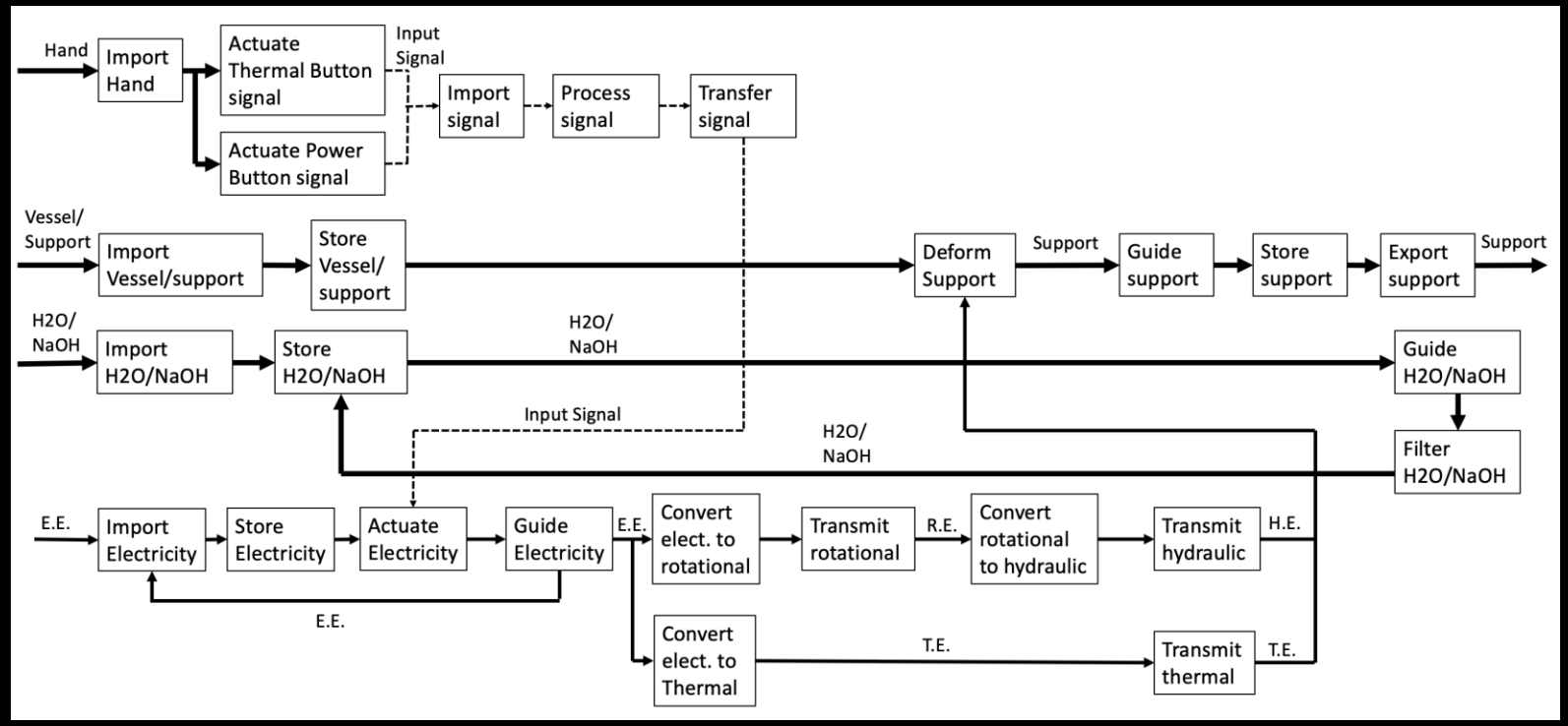

Figure 4: Functional Model

Concept Generation

Evaluated Concepts:

- Heating
- Sensors*
- Filtration methods
- Frame Material
- Transportation*

All concepts were evaluated using a Morph Matrix/Decision Matrix hybrid method

* Little to no coverage in presentation for consideration of time

Sample Concept Variants

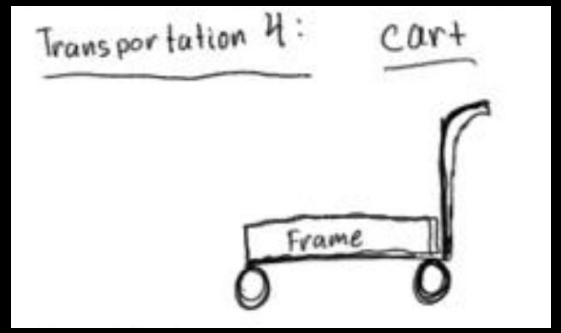

Figure 5: Cart Design

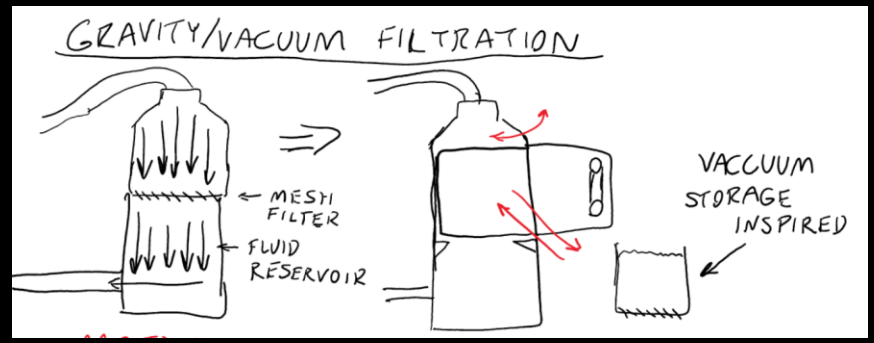

Figure 7: Filtration Model

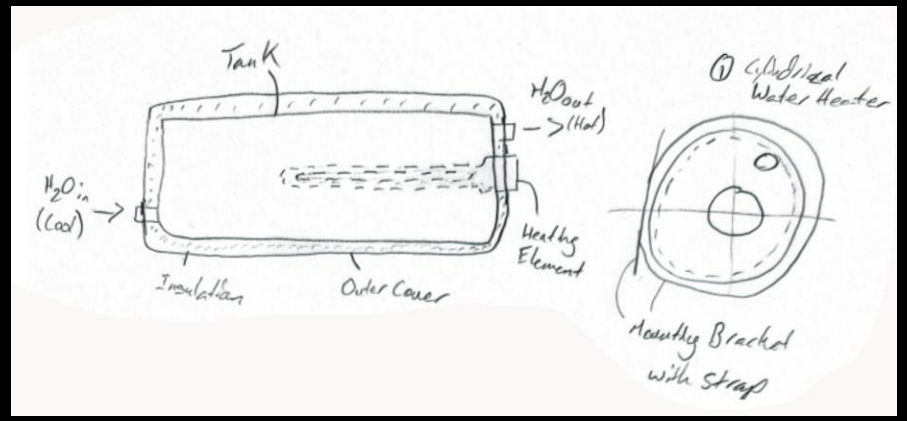

Figure 6: Heating Design

Decision Matrices

Table 1: Heating Element Decision Matrix

Heating Element		Hot plate		Camco heating	
Criteria	Weight (%)	Score	Weighted Score	Score	Weighted Score
Cost	0.3	5	1.5	10	3
Waterproof	0.3	4	1.2	7	2.1
Safe	0.2	5	1	6	1.2
Control	0.2	7	1.4	5	1
Total	1	21	5.1	28	7.3

Decision Matrices (Continued)

Table 2: Frame Material Decision Matrix

Frame Material		Wood		Concrete		Steel	
Criteria	Weight %	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Manufacturable	0.5	7	3.5	2	1	6	3
Strength	0.2	6	1.2	10	2	10	2
Cost	0.3	10	3	6	1.8	4	1.2
Total	1	23	7.7	18	4.8	20	6.2

Decision Matrices (Continued)

Table 3: Filtration Decision Matrix

Filtration		Vacuum		Clamping		Branch	
Criteria	Weight %	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Cost	0.3	3	0.9	5	1.5	7	2.1
Manufacturable	0.3	3	0.9	5	1.5	8	2.4
Efficiency	0.2	6	1.2	4	0.8	6	1.2
Recycling Material	0.2	8	1.6	6	1.2	6	1.2
Total	1	23	4.6	20	5	27	6.9

Preliminary Design (Flowchart)

- Based on Functional Modeling and Final concepts.

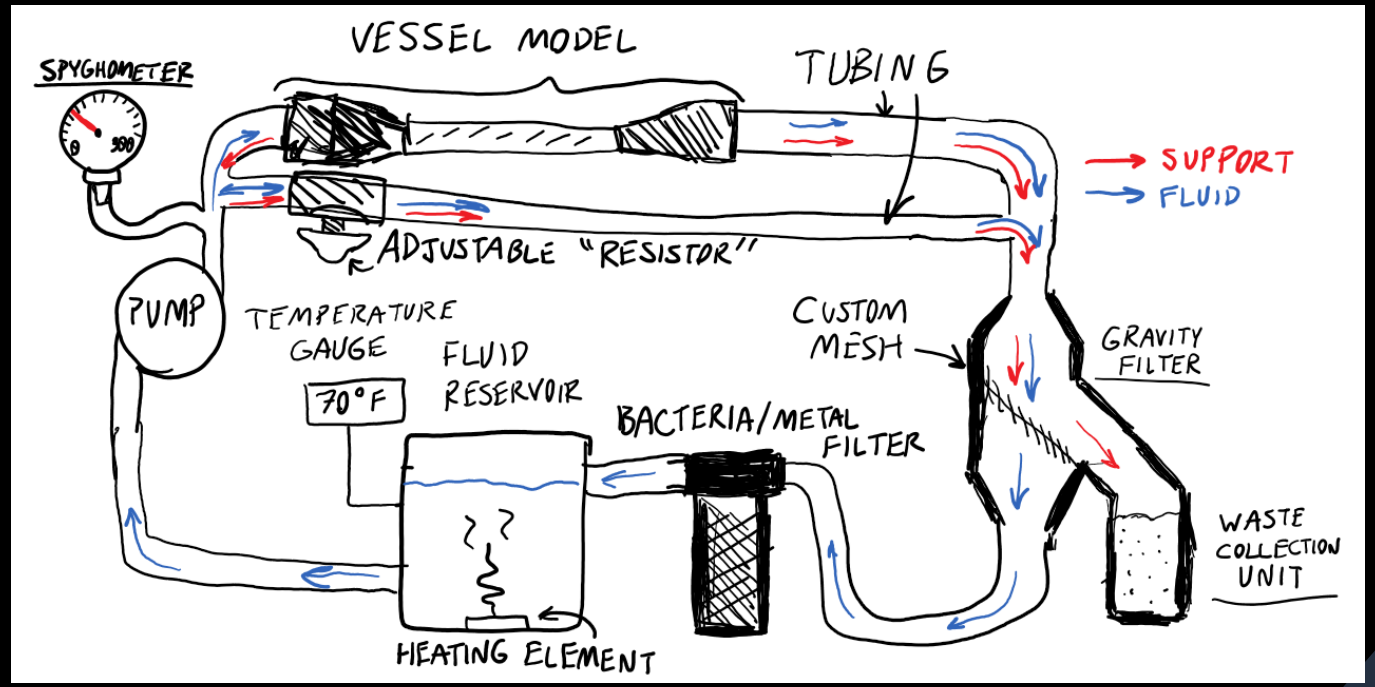

Figure 8: Design Flowchart

Preliminary Design (CAD)

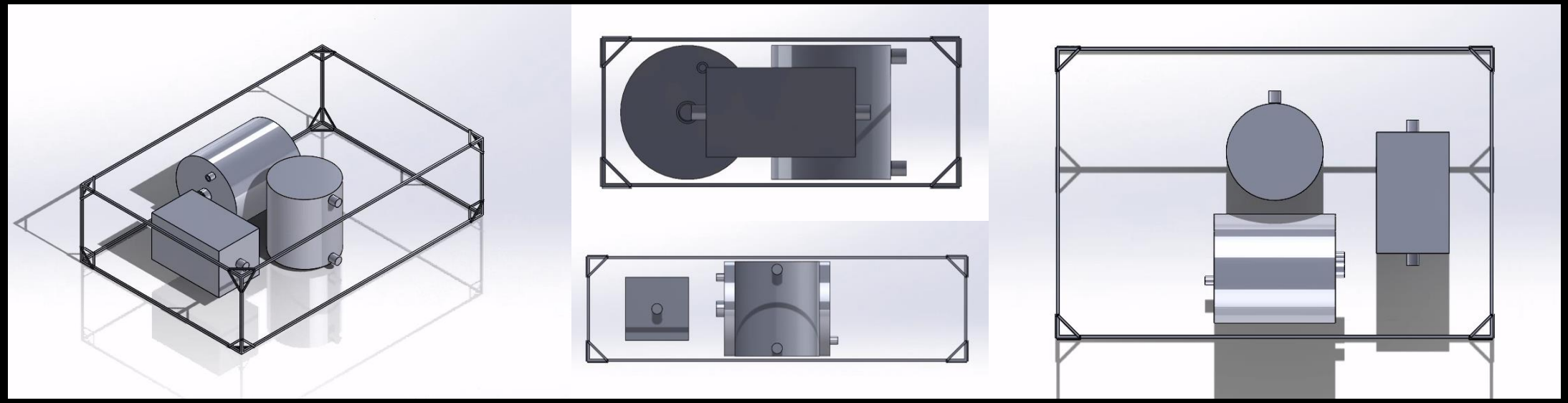

Figure 9: Preliminary Assembly Model (Left): Isometric view, (Top): Right view, (Bottom): Front View, (Right): Top view

Budget Planning

Total values for each item:
- Sensors/Electronics: $118.34
- Filtration: $155.43
- Frame Materials: $23
- Fluid Elements: $63
- Vessel Models: $150
- Taxes: $51

Predicted Expenses: $560.74

Contingency Budget: $939.25

Table 4: Bill of Materials

Bill of Materials	$
sphygmomanometer	16.95
Pump	32.99
Temperature gauge	27.99
Fluid Reservior	27.99
Metal Filter	13.99
Gravity Filter	109.94
Waste Collection Unit	15.49
Custom Mesh	15.99
Tubing	1.73
Heating Element	39.99
Introducer	38.76
Vessel Material	109
screw	8.97
wood	14.3
Arduino Board	26
Thermocouple	7.39

Fulfilled Customer Needs

- Measures Pressure, Temperature, and Time
- Includes Fluid Reservoir and Fluid Pump
- Supplies Heat to Fluid Reservoir
- Filters Support Material from Fluid
- Within Budget and Dimensional Constraints

References

Table 5: Commercial Supplies URL List

Reference
https://www.amazon.com/s?k=sphygmomanometer&crid=1C294IYWLTOKB&sprefix=%2Caps%2C1204&ref=nb_sb_noss
https://www.amazon.com/Pumteck-Electric-Inflation-Basketball-Volleyball/dp/B0869379NP/ref=sr_1_8?crid=3O6PKYX7UEZQ3&keywords=Pump&qid=1645627575&sprefix=pum
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https://www.amazon.com/s?k=Vessel+Material&crid=2G00N1FU8WBMC&sprefix=%2Caps%2C466&ref=nb_sb_noss
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https://www.amazon.com/HiLetgo-MAX6675-Thermocouple-Temperature-Arduino/dp/B01HT871SO/ref=sr_1_1_sspa?keywords=thermocouple+arduino&qid=1645659533&sr=8-

Questions?