DALHOUSIE UNIVERSITY
FACULTY OF ENGINEERING
Department of Electrical and Computer Engineering

Microfluidic Pump Design

Sieben lab
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Project Background

Everything that happens in the ocean has a significant impact on our daily lives in Halifax. Having a sustained monitoring platform will help provide a better solution when it comes to tackling climate change and its regional impacts.

We focused on developing a microfluidic pump as part of our effort to develop an in-situ microfluidic sensor for freshwater and deep ocean monitoring. A microfluidic pump enables the possibility for a compact, ruggedized and cost-effective sensor to be deployed in a large scale aquatic monitoring network.

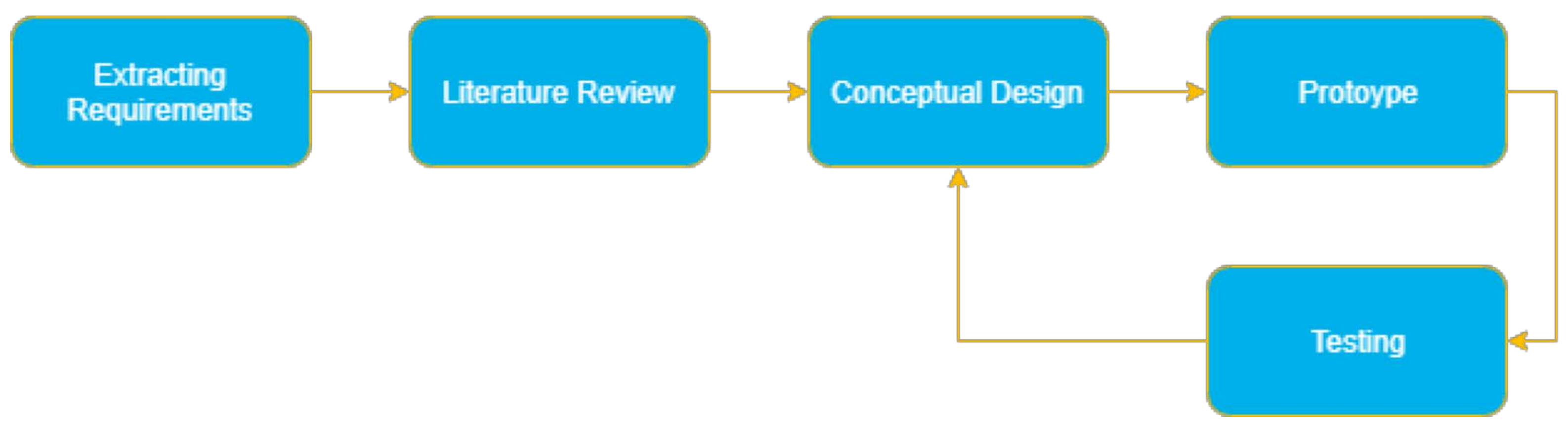
Advantages

- On-chip enables the reduction of dead volume.
- Potential massive-parallel experiments.
- Reducing consumption of reagents.
- Increased flow and media control.

Design Challenges

- Ruggedized: suitable for rough transportation & deployment.
- High pressured environment: target depth 2000 m.
- Efficient sampling rating: 6.8mL/min.
- Easily mass-scale in manufacturing.
- Compact and modularized.

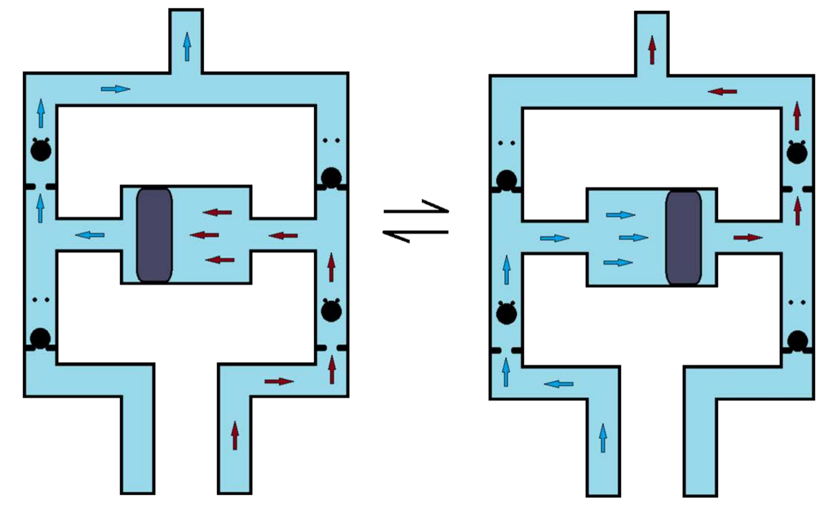
Design Process



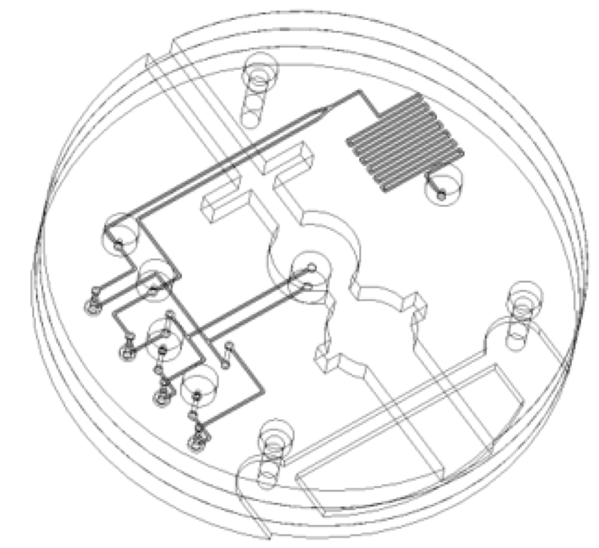
A few microfluidic chips were made throughout the design process.

Details of Design

Conceptualization

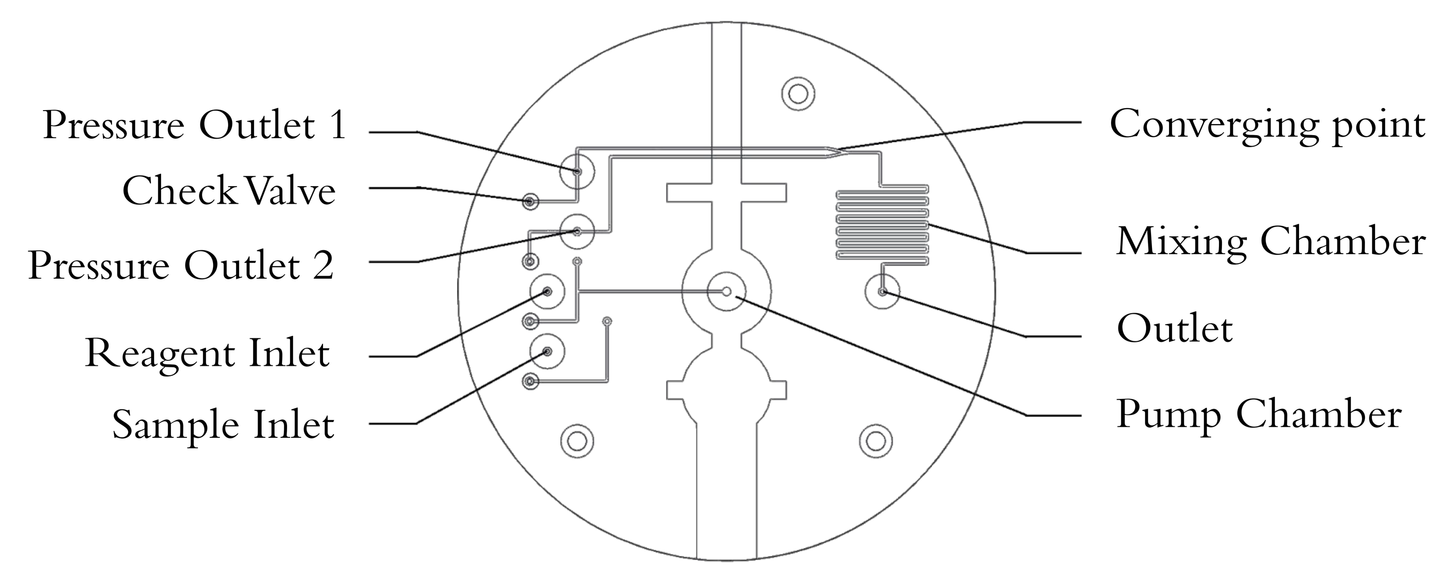


CAD



Prototype

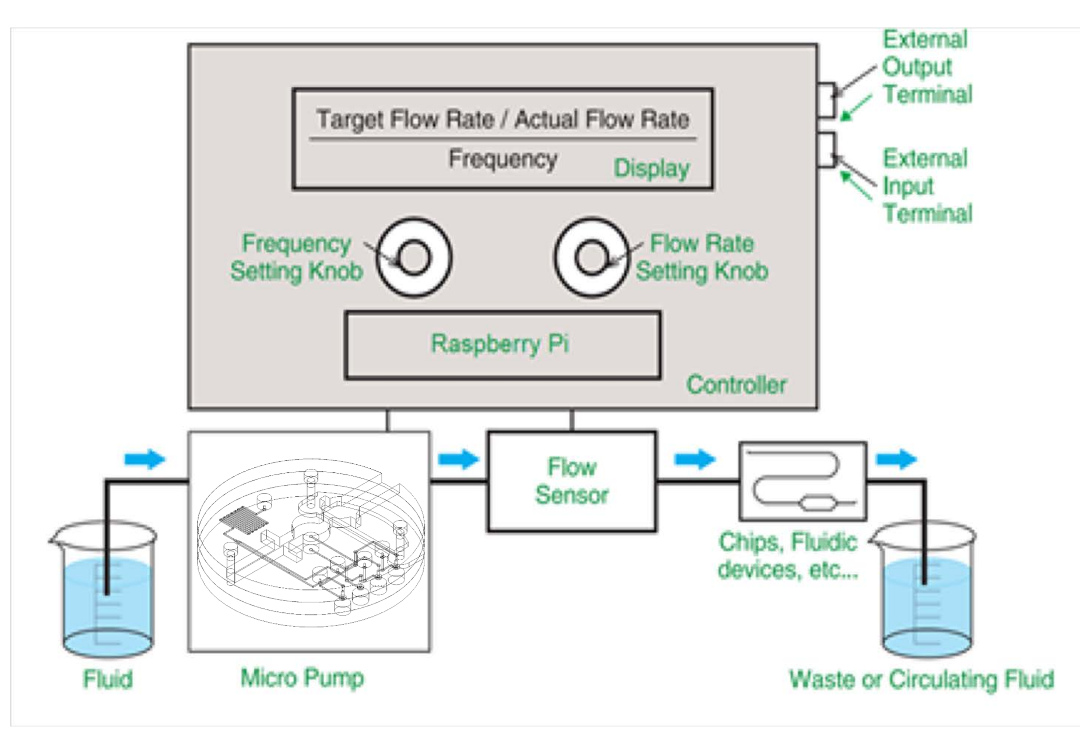
Layout



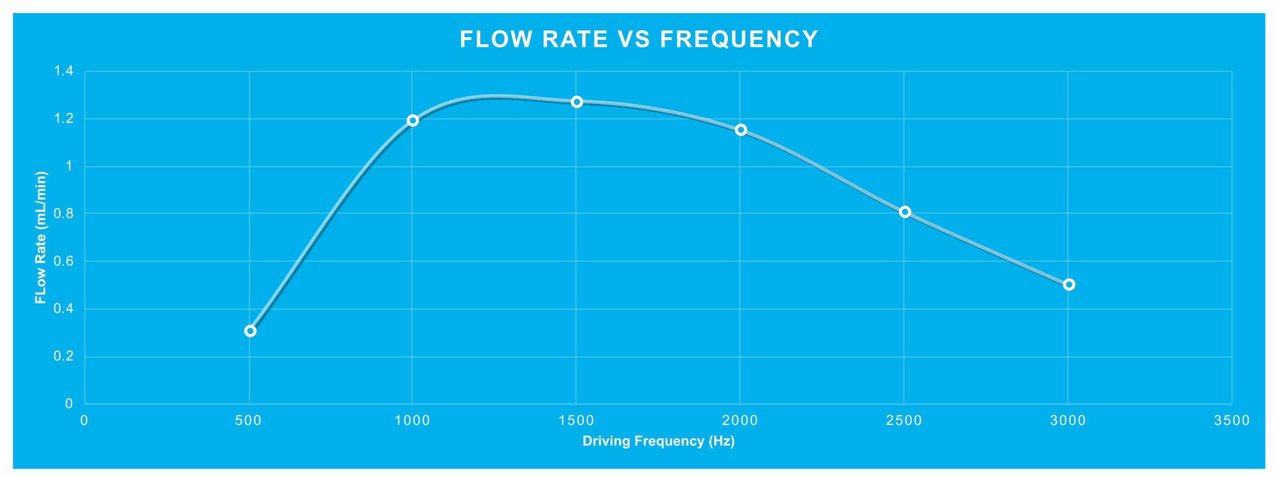
- PMMA material for rough transportation and deployment.
- Chloroform bonding to withstand the pressure.
- H-shaped configuration for sampling efficiency.
- Micropump as a standalone chip for modularity.
- PMMA and magnets for cost efficiency.
- 3-Layer design for easy manufacturing.

Results

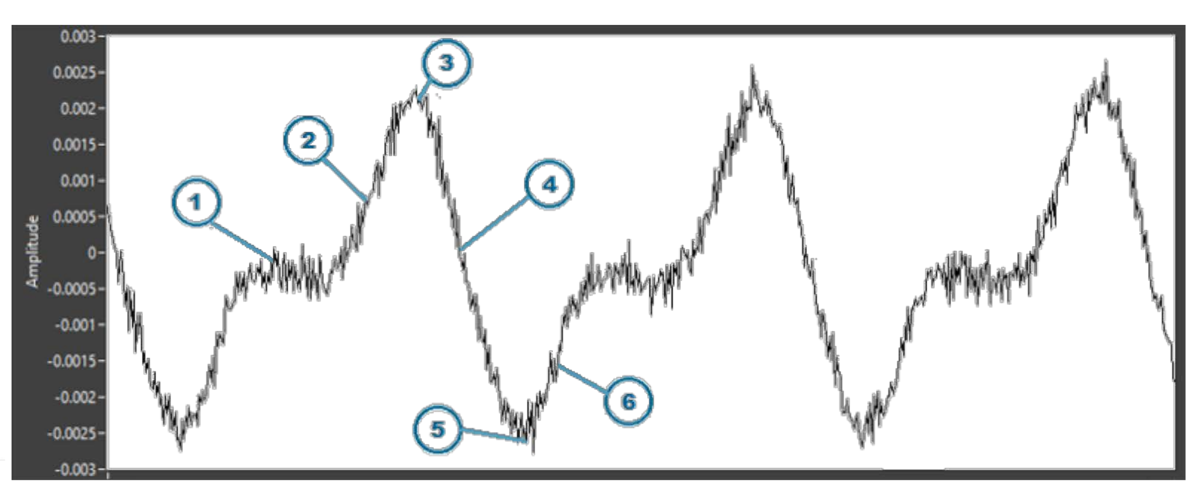
Test Setup



- Tested the micropump on varying operating frequencies.
- Acquired data from pressure sensors.
- Calculated flow rate from pressure.



Pressure vs Time



1. Piston stationary at chamber edge.
2. Piston is stressed, pressure rises.
3. Valve opens at peak positive pressure.
4. Piston moves, fluid flows, pressure drops.
5. Fluid stops, valve closes.
6. Pressure falls back to baseline.

Conclusion & Recommendation

The team was able to develop a magnetically actuated micropump, that was easy to manufacture, compact, and cost effective. The micropump will be incorporated into in-situ microfluidic sensors, allowing for more accurate data to be acquired for ocean monitoring. We recommend that a detailed numerical flow simulation is carried out in the future and using a solenoid to replace the stepper motor for further miniaturization.

Acknowledgement

The team would like to thank the client Dr. Vincent Sieben for providing the resources needed to make the pump, as well as his guidance along the way. The team would also like to express our gratitude to Dr Kamal El-Sankary as our internal supervisor. Finally, the team would like to thank the help and support from Seam Morgan, Eddy Luy and Sarina Lee.

References

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