UNIVERSITY OF WASHINGTON, BOTHELL. MENTORED BY TEDDY JOHNSON. SPECIAL THANKS TO DR. SHIMA ABADI AND SEA-BIRD SCIENTIFIC.

AUTONOMOUS UNDERWATER PROFILER

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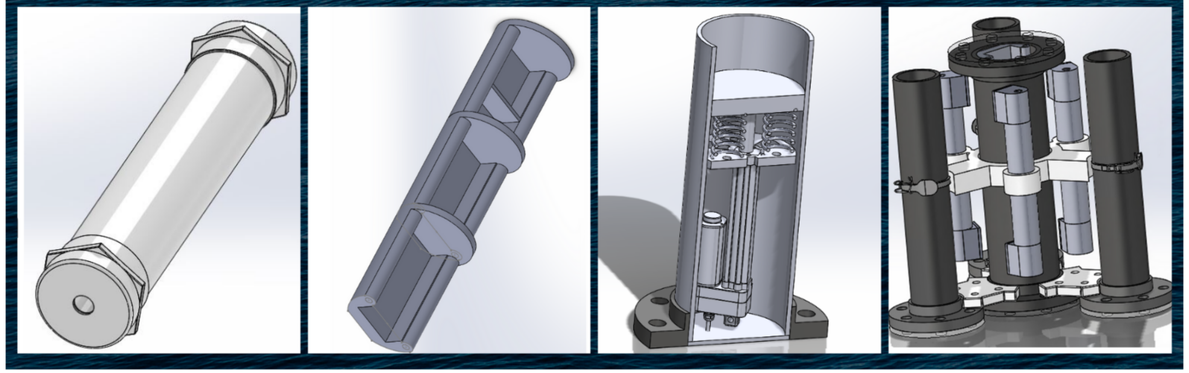
PROBLEM

Biologists and data scientists at UW Bothell are in need of an inexpensive and easily deployable means for collecting data to assess the health of local bodies of water by taking measurements at varying depths.

DESIGN EVOLUTION

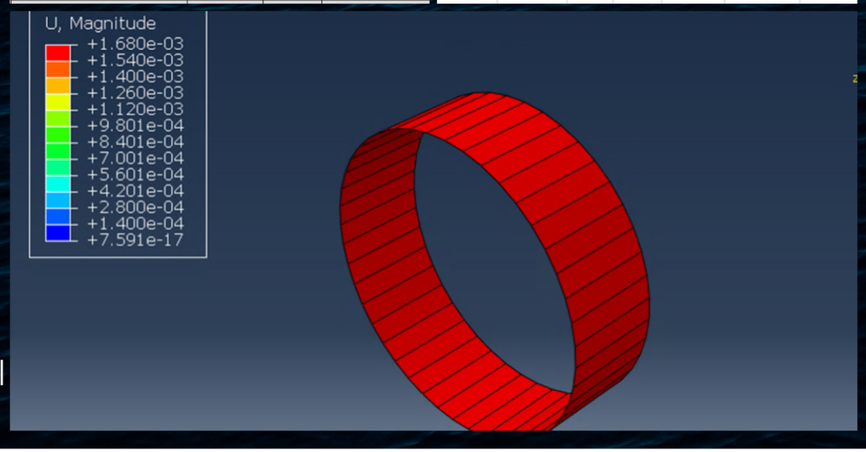


EXPERIMENTS

1. Determine the required actuating force on a syringe.
2. Determine the system density change with changing water volumes.
3. Determine maximum pressure on either side of the piston head.
4. Determine the depth at which the profiler would critically buckle.
5. Determine cylinder compression around the piston head.
6. Use the Parker O-ring Handbook to determine the appropriate O-ring seal for the piston head.

	Given Value	Unit:	Value (Converted)
Total Design Weight			
PVC	52.68	lbm	23.893
High Density Polyethylene	57.29	lbm	25.986
Water Calculations			
Total Water Volume (Single Cylinder)	66.27	in^3	0.001
Initial Water Displacement	148.63	in^3	0.002
Profiler Density with Water Intake			
Total Water Volume (Three Cylinders)	198.804	in^3	0.003
Total Volume of the Profiler	1,482.323	in^3	0.024
Water Required to Submerge	24.282	in^3	0.000
Water that can be used to adjust buoyancy	174.522	in^3	0.003
Water Pressure on Piston Head			
Mass of water	2.394	lbm	1.086
Radius of Buoyancy Cylinder	1.875	in	0.048
Cross Sectional Area of Cylinder	11.045	in^2	0.007
Force of Water Applied to Piston Head	356.790	lbf	1,587.079
Air Pressure on Piston Head			
Maximum Volume around Motor	197.929	in^3	0.003
Minimum Volume around Motor	82.835	in^3	0.001
Cross Sectional Area that Pressure Acts on	5.940	in^2	0.004
Pressure at Minimum Volume	20.354	psi	140,333.120
Force of Air Applied to Piston Head	120.892	lbf	537.753
Speed of Descent			
Velocity of Profiler			
Terminal Velocity of Profiler	2.886284314	mph	1.290
Reference Area	285.8849315	in^2	0.184
Drag Force	28.30265164	lbf	125.896

Nom.Size (in)	O.D.	Min. Wall	Nom. Wt./Ft.	Max. W.P. PSI**
1/8"	.405	0.095	0.058	1230
1/4"	.540	0.119	0.100	1130
3/8"	.675	0.126	0.138	920
1/2"	.840	0.147	0.202	850
3/4"	1.050	0.154	0.279	690
1"	1.315	0.179	0.402	630
1-1/4"	1.660	0.191	0.554	520
1-1/2"	1.900	0.200	0.673	470
2"	2.375	0.218	0.932	400
2-1/2"	2.875	0.276	1.419	420
3"	3.500	0.300	1.903	370
3-1/2"	4.000	0.318	2.322	350
4"	4.500	0.337	2.782	320
5"	5.563	0.375	3.867	290
6"	6.625	0.432	5.313	280
8"	8.625	0.500	8.058	250



RESULTS

1. We should not use syringes as pistons due to the great amount of force required to actuate one.
2. Change in density is large enough for the profiler to reach the desired depth.
3. Springs will be needed to assist the linear actuator.
4. The crush depth is far greater than the target depth, so it is not a concern.
5. Compression around the piston head is negligible.
6. An O-ring was chosen that wouldn't extrude or create large amounts of friction.

FINAL DESIGN

- Modular cylinders with 3D printed brackets.
- Central cylinder houses electronics. Wiring harness emphasizes modularity and reliability, can be expanded to support additional instruments
- Large exterior cylinders used for buoyancy control. Piston pushed with linear actuators and springs.
- Small exterior cylinders have valves that open to take in water samples.
- Easily deployable and easy to work with. It does not require a permit to deploy.
- Can reach a depth of 30 feet and resurface quickly.
- Inexpensive and convenient way for researches with low budgets to study underwater properties.
- Future iterations of the profiler could add modular section specific to the needs of the researcher.