

Don't Crack Under Pressure: Creating a Pressure-Tolerant Circuit board

EXWC Oceans Department

PIPELINES Design Challenge, Summer 2019

Team Membership:

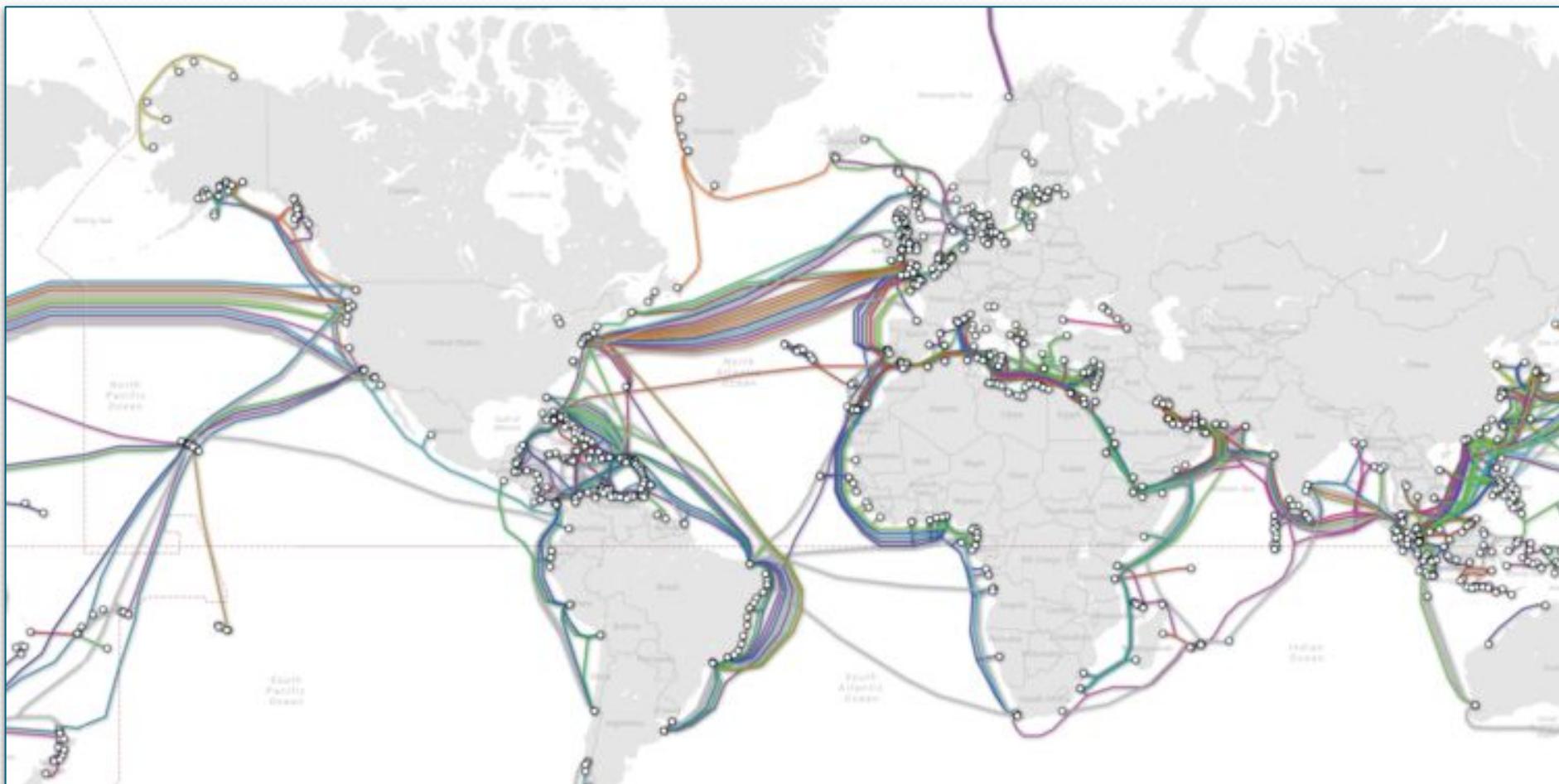
Team Members: Juan Carrillo, Emily Chapman

EXWC Project Lead: John B Hunter, PhD

UCSB Student Mentor: Nathan Tucker

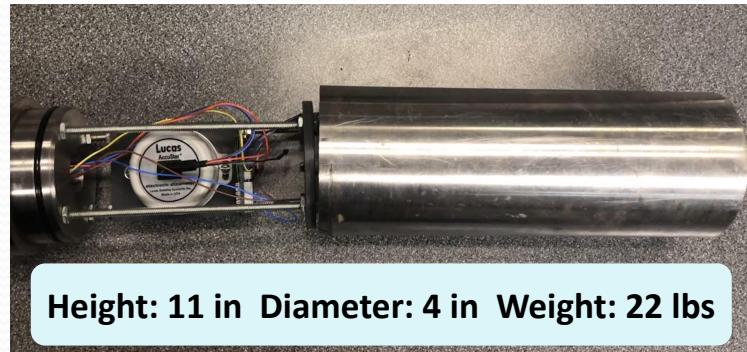


Map of Naval Undersea Cables

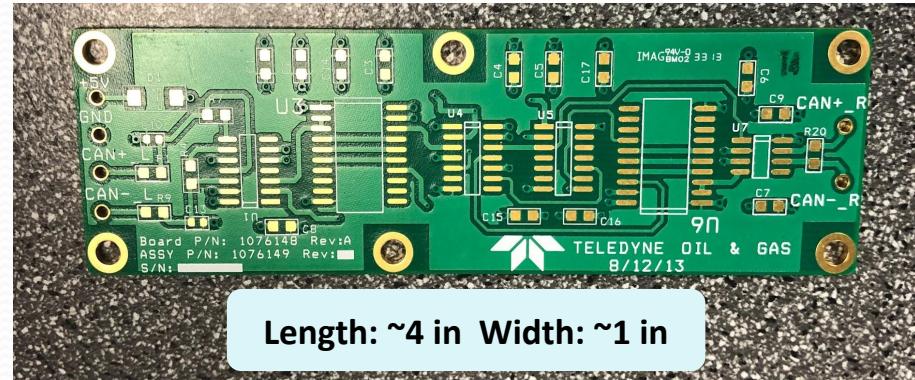


Designing a Pressure Tolerant Circuit Board

Old Technology



Our Goal



Benefits to the Navy

- Easier deployment
- Increase reliability
- Reduce cost
- Increase communication capability

Requirements and Constraints

Requirements:

- Pressure tolerant (2,500 psi)
 - ~ 5,000 feet underwater
- 80% weight reduction
 - Compact
- Withstand 6 months underwater

Constraints:

- Circuit board must be designed, printed, and tested in-house
- Withstand exposure to seawater
- Heat conduction

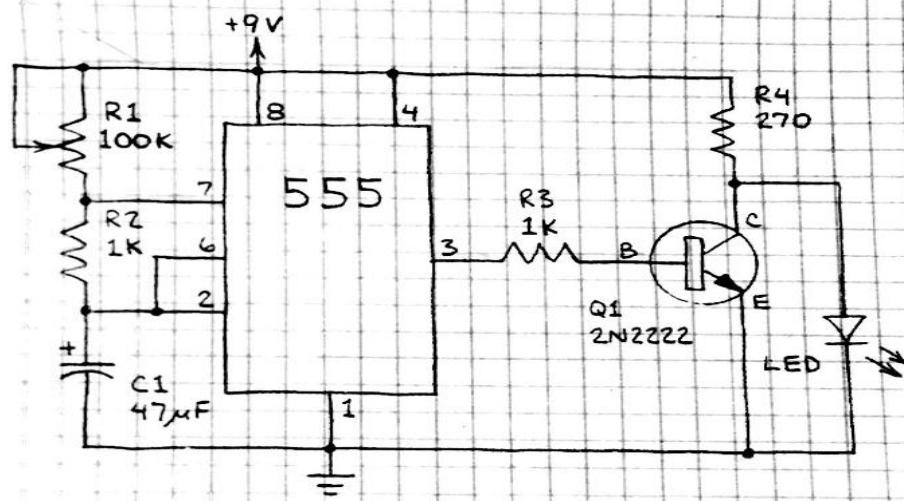


The background features a light gray grid pattern. Overlaid on the top edge are several wavy, translucent teal lines of varying thicknesses, creating a sense of depth and motion.

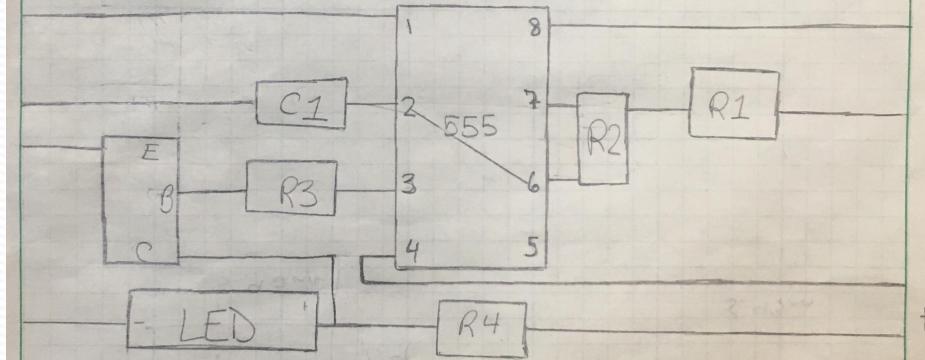
Design

Our Circuit Design

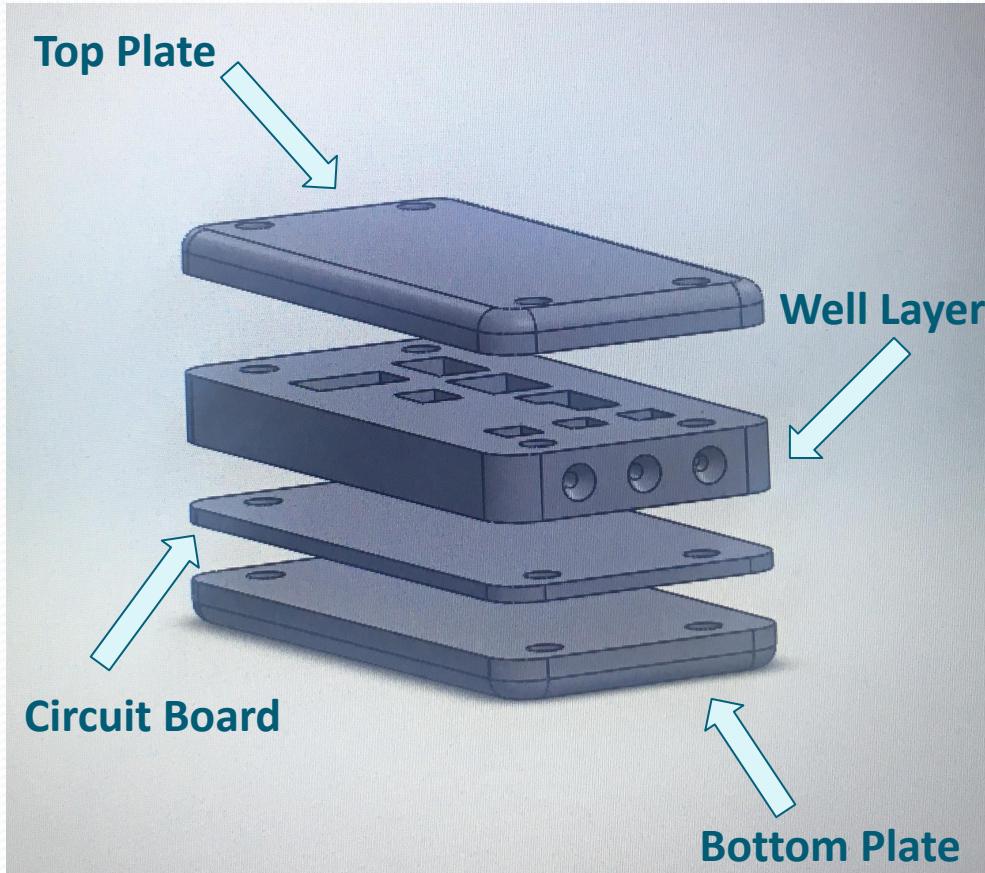
LED FLASHER

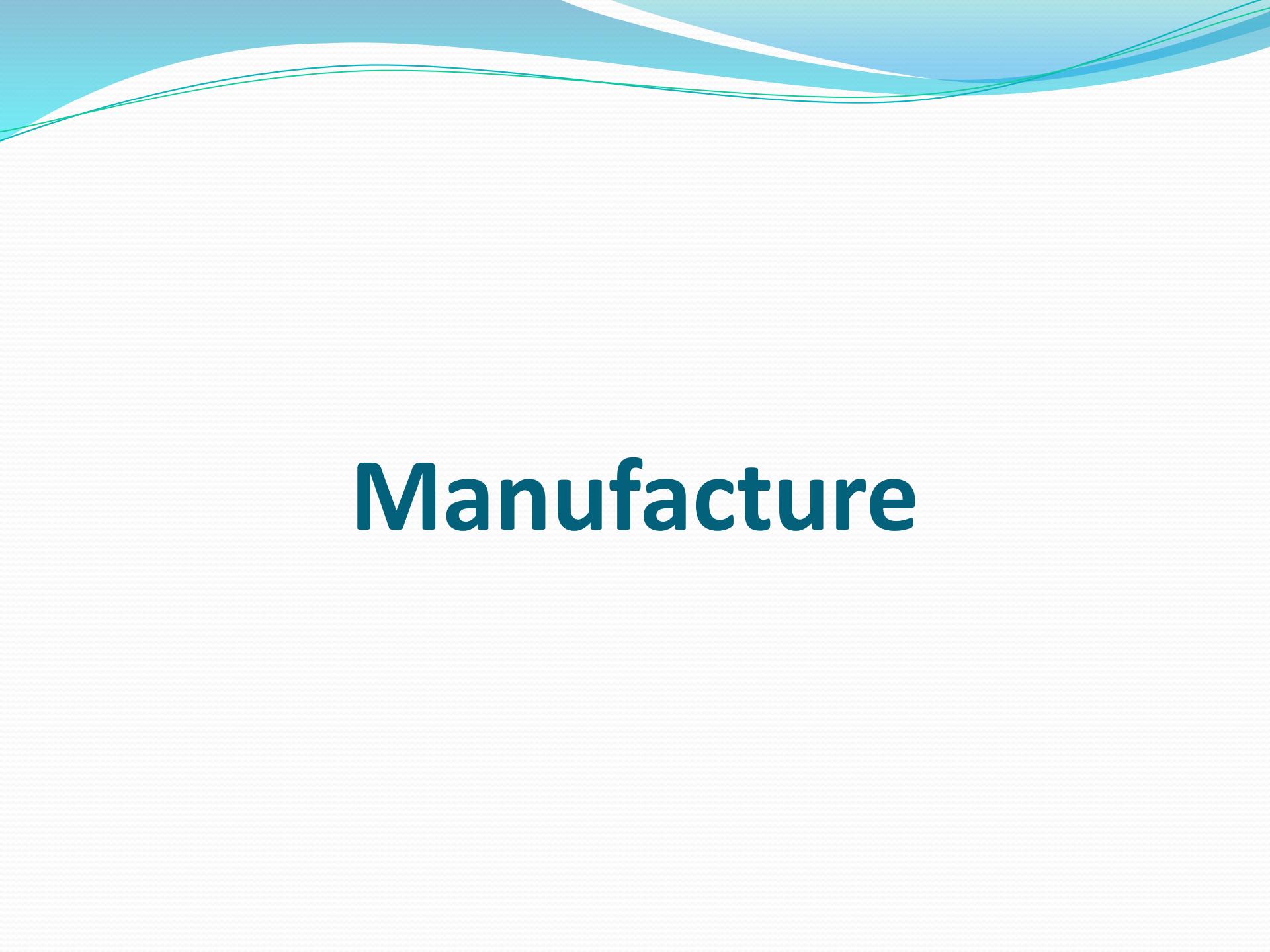


Revised Diagram



Our Casing Design





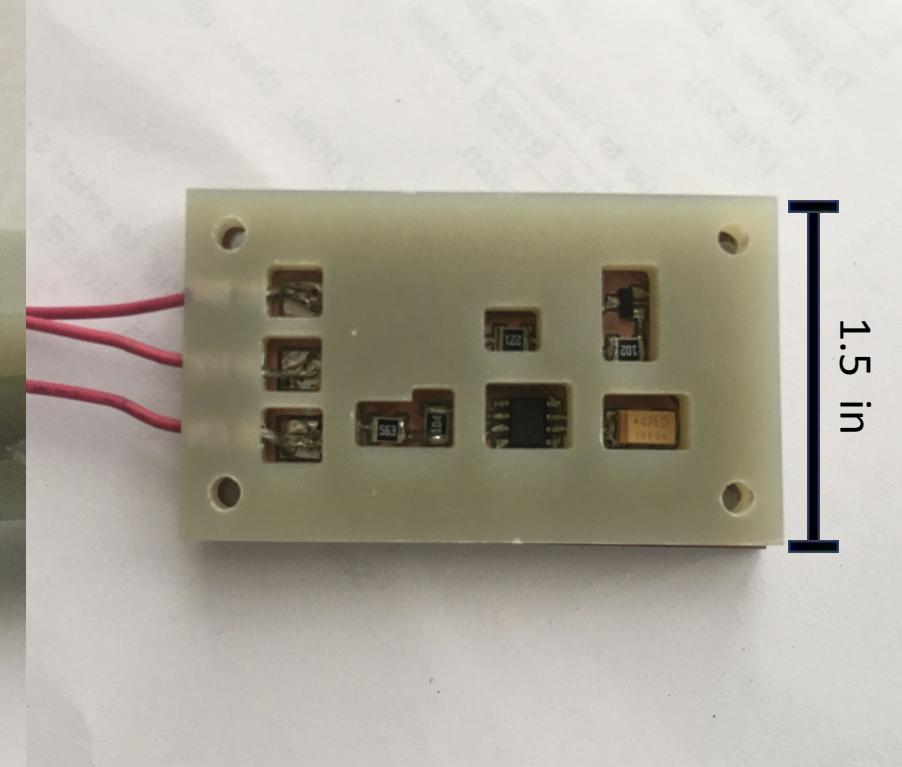
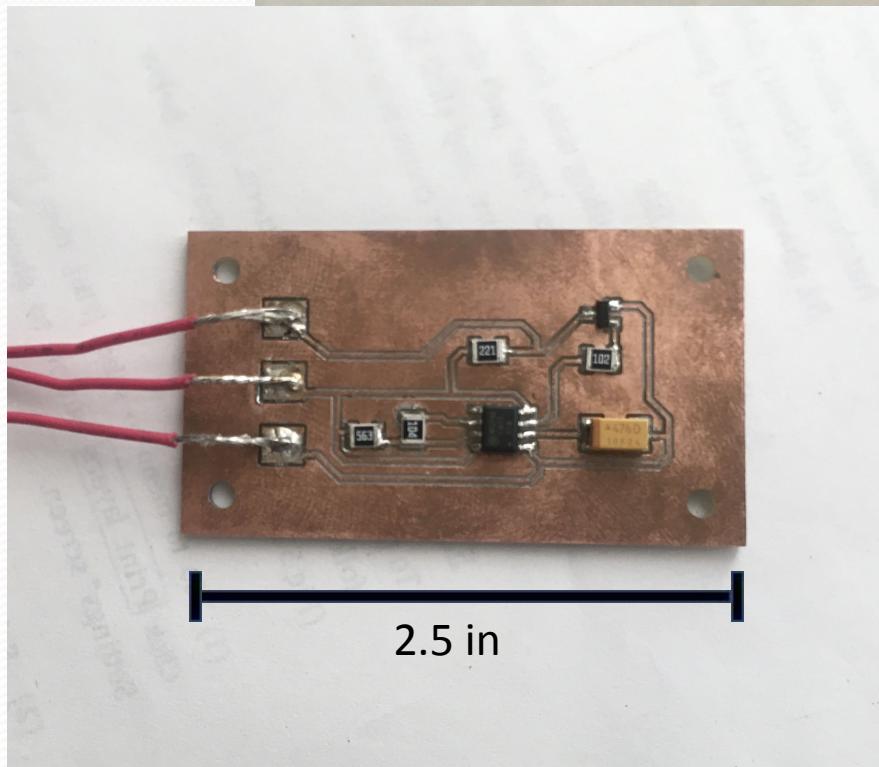
Manufacture

Materials: Garolite

- Material: G10 Garolite
- Properties: High Strength, low moisture absorption, high level of electrical insulation
- Compressive Strength: 35,000-68,000 psi
- Tensile Strength: 32,000-40,000 psi



Printing



Materials: Epoxy and Sealant

JB Marine Weld Epoxy

- Tensile Strength: 3,200 psi
- Waterproof
- Designed for Marine Applications



Dichtol WFT

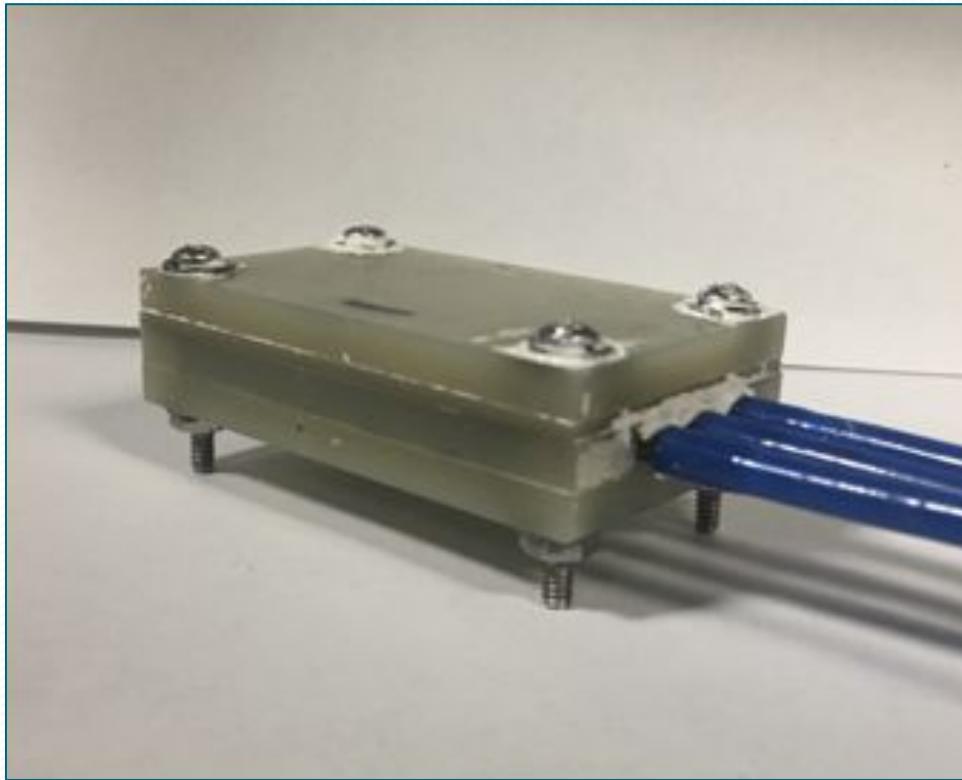
- Capillary Sealant
- Compressive Strength: 5,000 psi

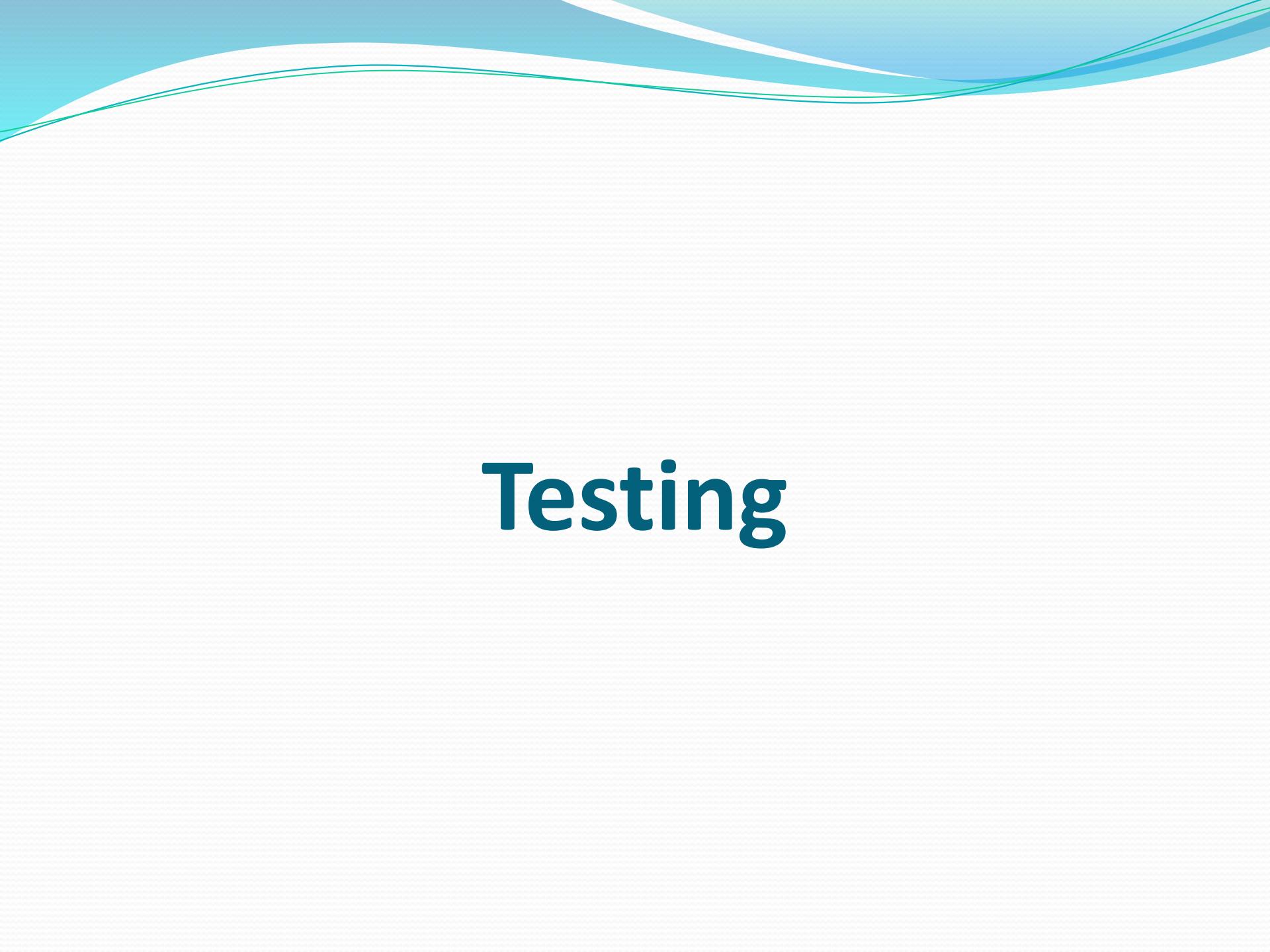


Dichtol WFT

JB Weld Marine
Weld Epoxy

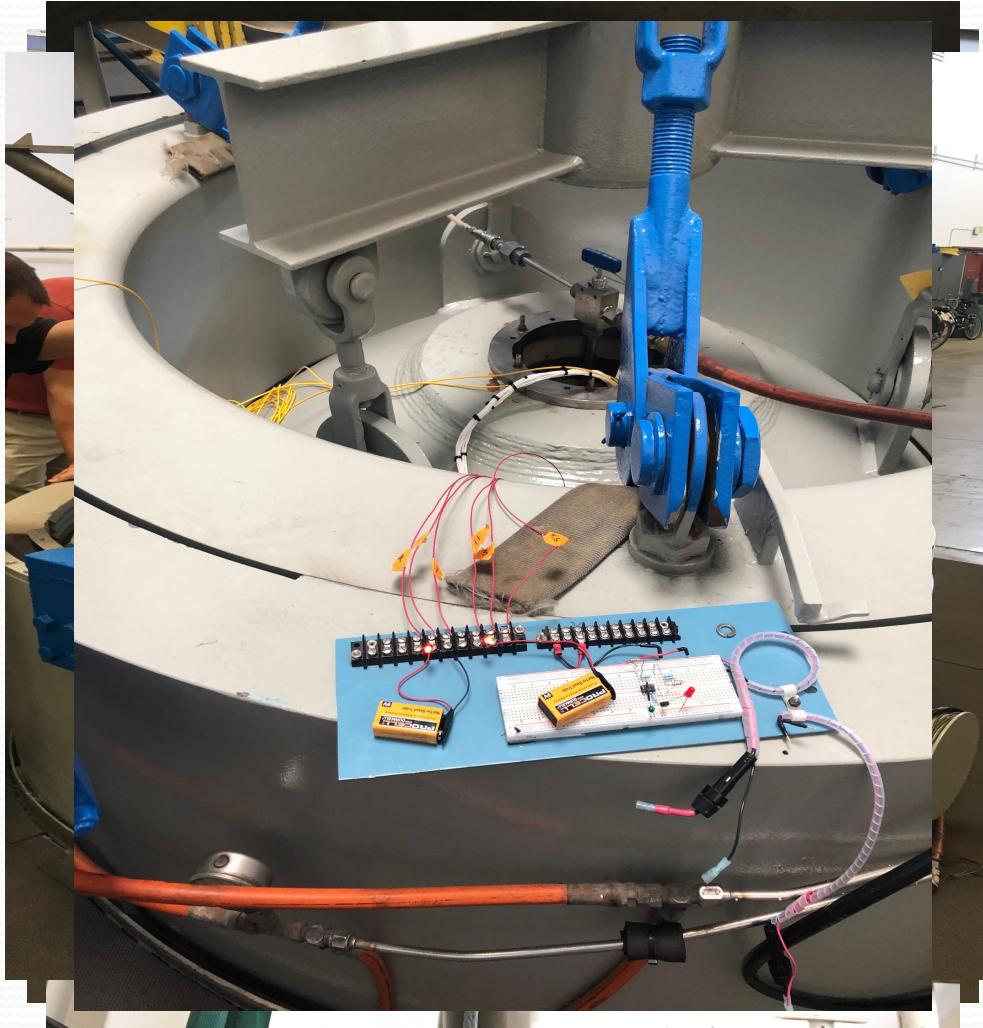
Assembled Prototype



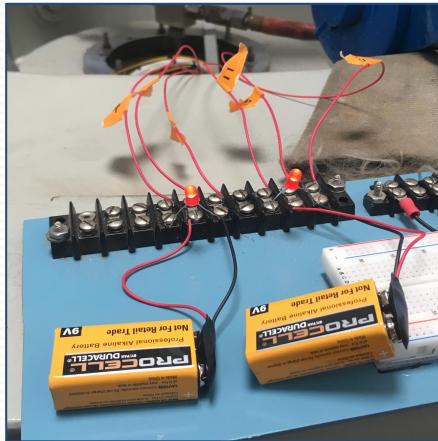


Testing

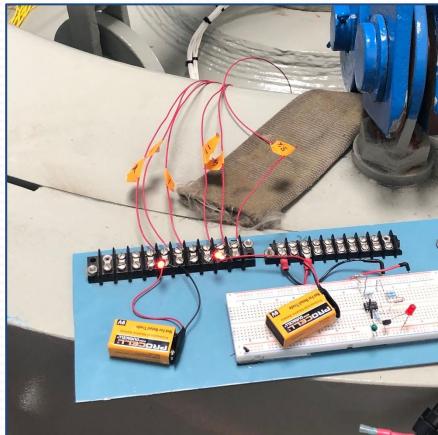
Test Setup in Deep Oceans Lab (DOL)



Testing Results in the DOL



0 psi



4500 psi

FINAL RESULTS	Circuit 1	Circuit 2
500 psi	✓	✓
1,000 psi	✓	✓
1,500 psi	✓	✓
2,000 psi	✓	✓
2,500 psi	?	✓
3,000 psi	?	✓
3,500 psi	?	✓
4,000 psi	?	✓
4,500 psi	?	✓

Analysis

	Our Design	Metal Canisters
Pressure tolerant to 2,500 psi		?
Weight	1.5 lbs	> 20 lbs
Multi-layer Circuits	Multi-layer	Multi-layer
Reusability of housing	Single use	Interchangeable
Size	2.5" x 1.5" x 0.625"	Length: 12" Diameter: 4"

To Recap

Prototyped circuit board (LED Flasher)



Made printed circuit board (PCB)



Researched



Epoxy/Resin

Compact Casing



Prototyped



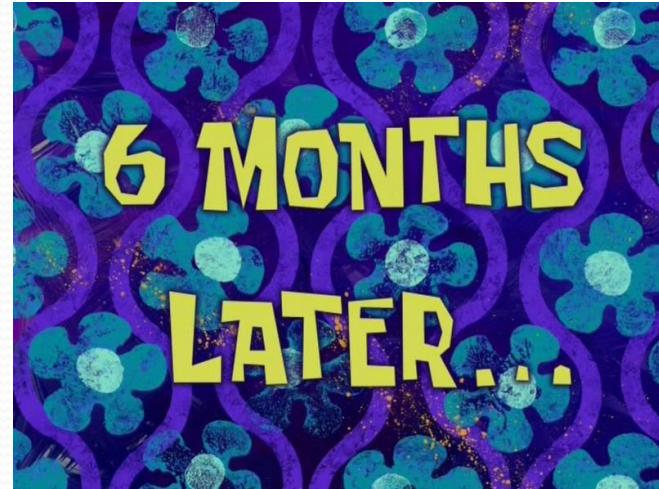
Tested in Deep Oceans Lab (DOL)



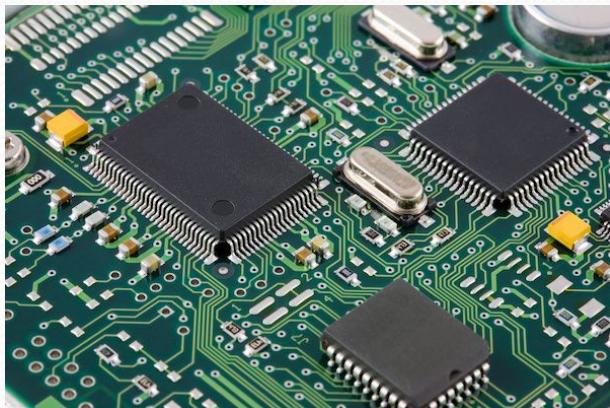
Future Work



Retesting in DOL



Age Testing



Complicated Circuits



Fiber Optic Cables



We Would Like to Thank...

John Bradley Hunter

Maria Napoli

Dave Warren

Nate Tucker

Abby Sandquist