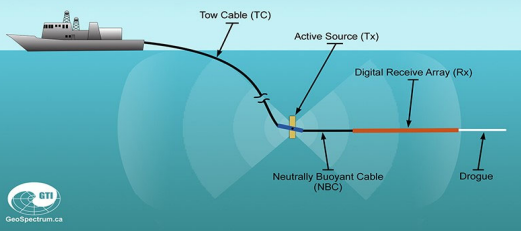


## INTRODUCTION

- Who** ULTRA is a naval engineering company that specializes in electronic defense systems
- What** A Towed Array Sonar is a series of modules towed behind a ship that detect underwater sound waves
- Why** ULTRA provides allied navies with these technologies for defence purposes and underwater research

## PROBLEM STATEMENT

Design an instrument that can determine in real time the tension in the towed array to better understand causes of Vectran rope failure



## DESIGN REQUIREMENTS AND CHALLENGES

- 1 Measure tension in real time
- 2 Minimize fraying due to tensile cycling
- 3 Oil compatible and environmentally rated
- 4 Design around proprietary information
- 5 Proof of concept

## DESIGN PROCESS

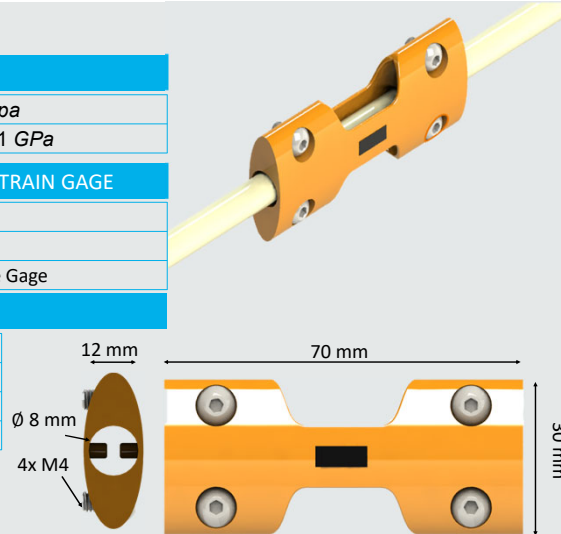
- 1 Ideate possible designs
- 2 Cost-benefit analysis
- 3 Evaluate designs based on requirements
- 4 Select final design
- 5 Finite Element Method (FEM)
- 6 Build, test, and improve

## SPECIFICATIONS

- 1 MATERIAL: PETG**

Tensile Strength	60-66 Mpa
Young's Modulus	2.01-2.11 GPa
- 2 MEASUREMENT METHOD: STRAIN GAGE**
  - 2x CEA-06-250UW-350 Strain Gage
  - OMEGA-Bridge Completion Module-1
  - 3-Wire Quarter Bridge Circuit – 1 Active Gage
- 3 DEVICE MEASUREMENTS**

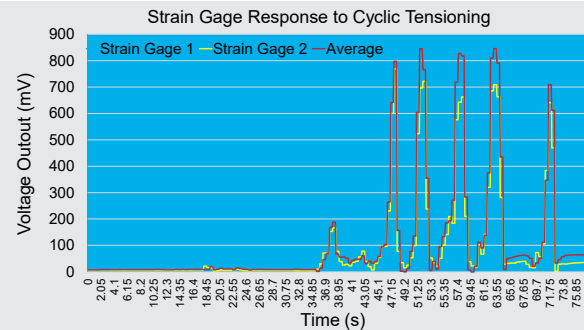
Mass	12.28 g
Volume	8800 mm <sup>3</sup>
Total Surface Area	9900 mm <sup>2</sup>
Safety Factor	2



## TESTING METHOD AND ANALYSIS

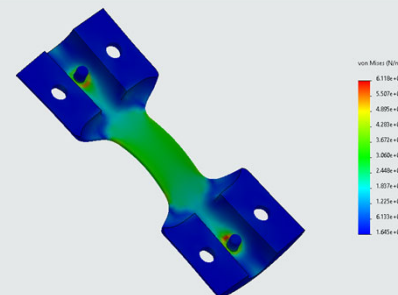
### PHYSICAL TESTING

- Subject tension device to cyclic loading with a known load
- Record response of the active gages on either side
- Average the response and produce voltage curve
- Correspond voltage response with known load and produce a tension calibration curve



### FINITE ELEMENT METHOD AND ANALYSIS

- Allows optimization of cross-section to:
  - Ensure uniform strain for gage area
  - Work within material limits
  - Maximize used range of strain gage
- Loading is shared between clamping and pins, simplified to only the pins for the FEM model. This results in false stress concentrations near the pins in the FEM model



## HOW DOES IT WORK?

- Soft plastic acts as a low stiffness spring
- Strain gage located in the middle and high strained area
- DAQ reads a voltage output and converts reading into a tension measurement

## FAST FACTS

- 99mm Diameter of the Towed Array
- 10,000 Maximum Tensile Force (lbf)
- 1 mm Maximum Elongation of Device
- ±2% Full Scale Accuracy Rating
- 6 and 2.77 Maximum Length and Diameter (mm) of Boundary Casing

## CONCLUSION AND RECOMMENDATIONS

- 1 Improve compatibility to help integrate system onto the towed array
- 2 Introduce an accelerometer to strengthen understanding of rope wear
- 3 Optimize device material to reduce fatigue due to tension cycling and to increase readability
- 4 Internalize strain gage design in the device to reduce wear on hardware
- 5 Implement an additional device on the module to synergize the output reading