

Design Review II: Interim Presentation

GROUP 21: NEW HOUSING STRUCTURE FOR DEEP SEA EQUIPMENT
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Introduction

- Tether Operated Vehicle (TOV)
 - Purpose is for surveying and exploring
 - Vehicle is dragged behind ship using tether
 - Holds data collecting equipment
 - Winch and pulley system control TOV altitude
- Florida State's TOV
 - 3 feet x 3 feet x 6 feet galvanized steel frame
 - Cruises very slowly at about 2000 meters under water
 - Currently has 17 pieces of data collecting equipment
 - Weighs approximately 900 pounds with all equipment

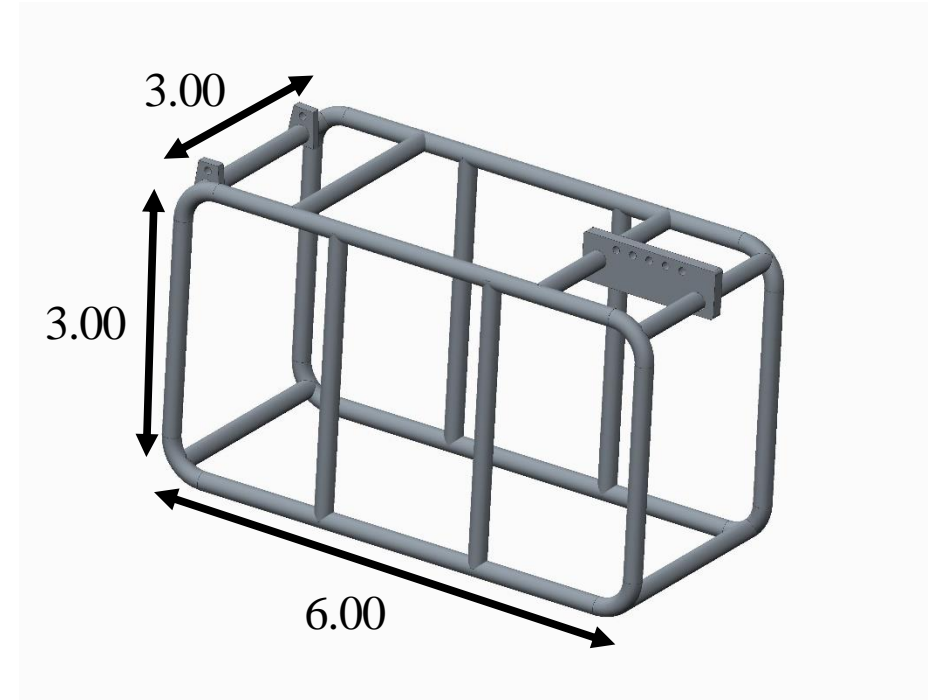
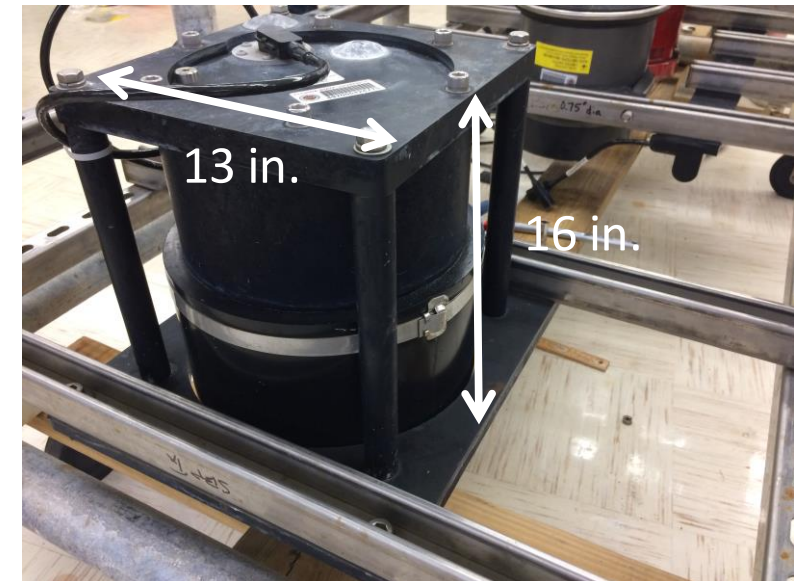
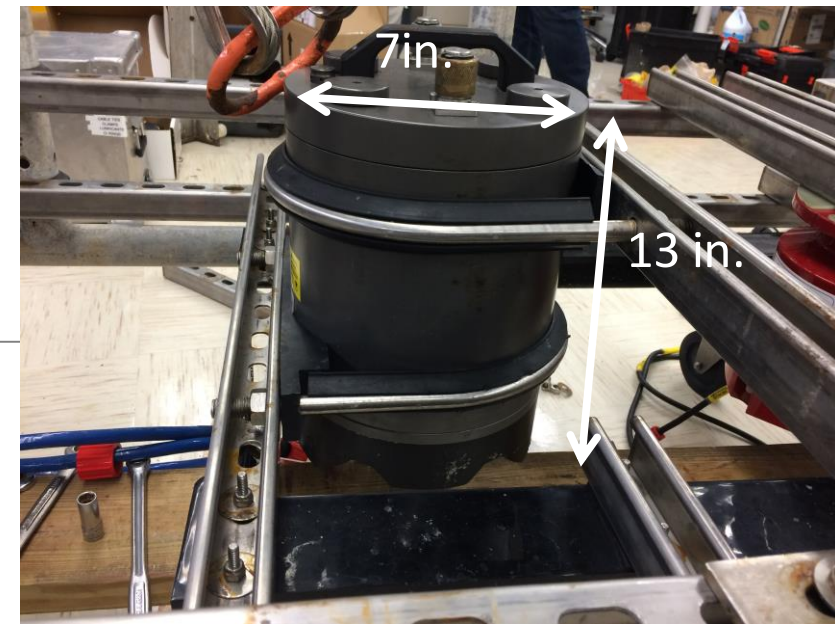


Figure 1: FSU's current TOV, in feet

Equipment

- Data Collecting Equipment
 - Lights
 - Cameras
 - Lasers
 - Surveying Equipment
 - Housing for Electronics
- Most are cylindrical
- Weights range from 1.7 to 80 pounds
- Largest component has 10.5 inch diameter, 30 inches long
- Total weight of components: 485 pounds



Review Scope

Problem Statement: Florida State University's (FSU) current tether operated vehicle (TOV) (seen in Figure 2) has too much empty space, is too heavy, is difficult to move around, and does not tow parallel to ocean floor.

Project Scope: Update FSU's current TOV to address above issues.

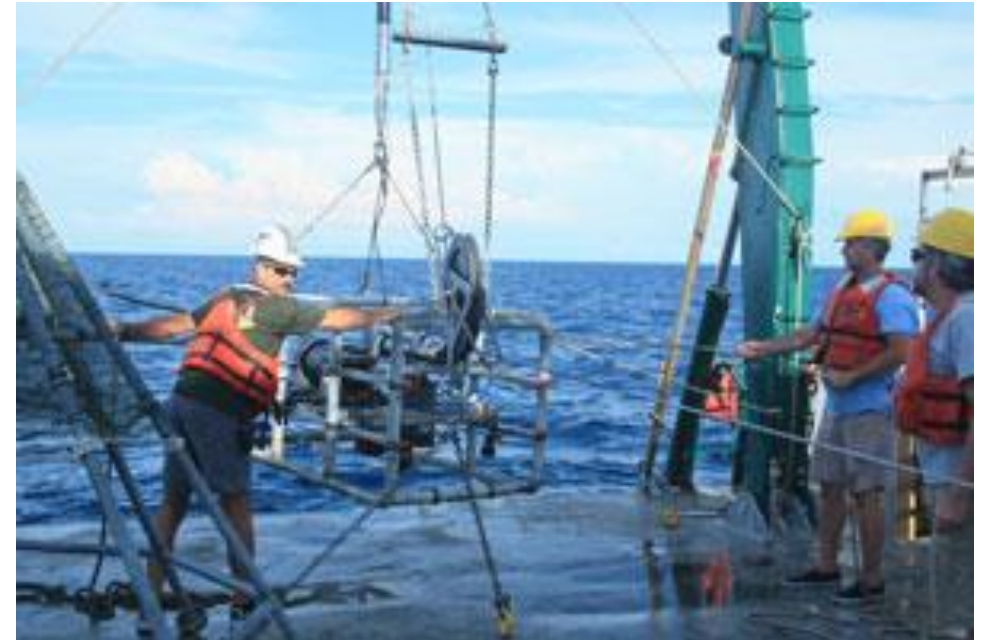


Figure 2: FSU TOV being loaded into water

Objectives and Constraints

Project Objectives

- Maximize footprint area
- Reduce weight
- Increase Modularity
- Maintain level towing angle, passively
- Minimize height of new frame

Project Constraints

- \$2,000 budget, flexible if absolutely necessary
- Corrosion resistant
- Hold all necessary equipment
- No extra power consumption
- Impact resistant

Design Concept 1

Advantages

- Square footprint maximizes area
- Allows all equipment to have a clear line of sight to ocean floor
- Low height will promote ease in deployment and retrieval
- Surfaces on sides create drag perpendicular to flow, promoting smooth towing conditions
- New total weight of 582 pounds

Disadvantages

- Increase in footprint will lead to an increase in volume

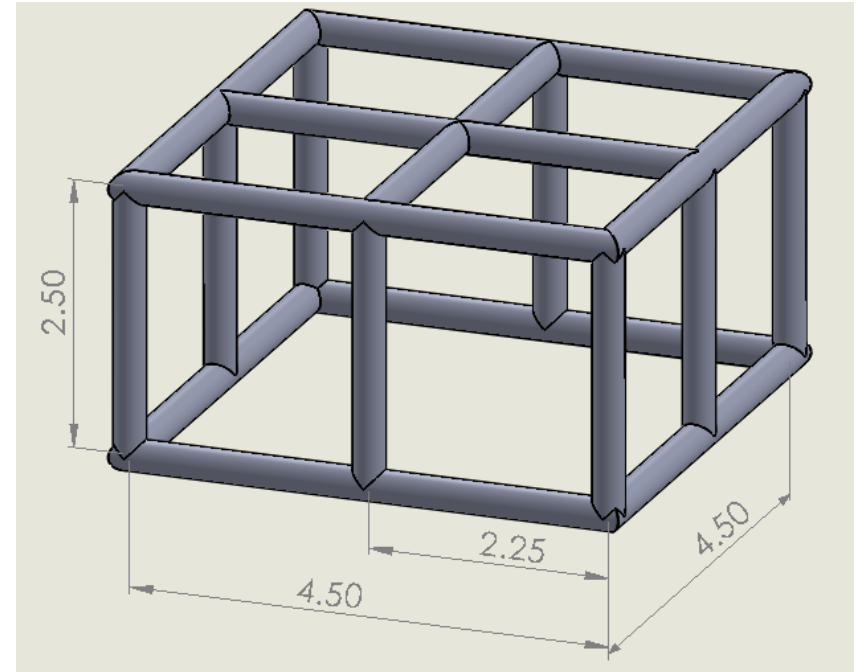


Figure 3: Design concept #1, units in feet

Design Concept 2

Advantages

- Surfaces on sides create drag perpendicular to flow, promoting smooth towing conditions
- Footprint area larger than current TOV
- Allows all equipment to have clear view of ocean floor
- New total weight of 543 pounds

Disadvantages

- Weight distribution could be uneven
- Smaller footprint area and larger height than design concept 1

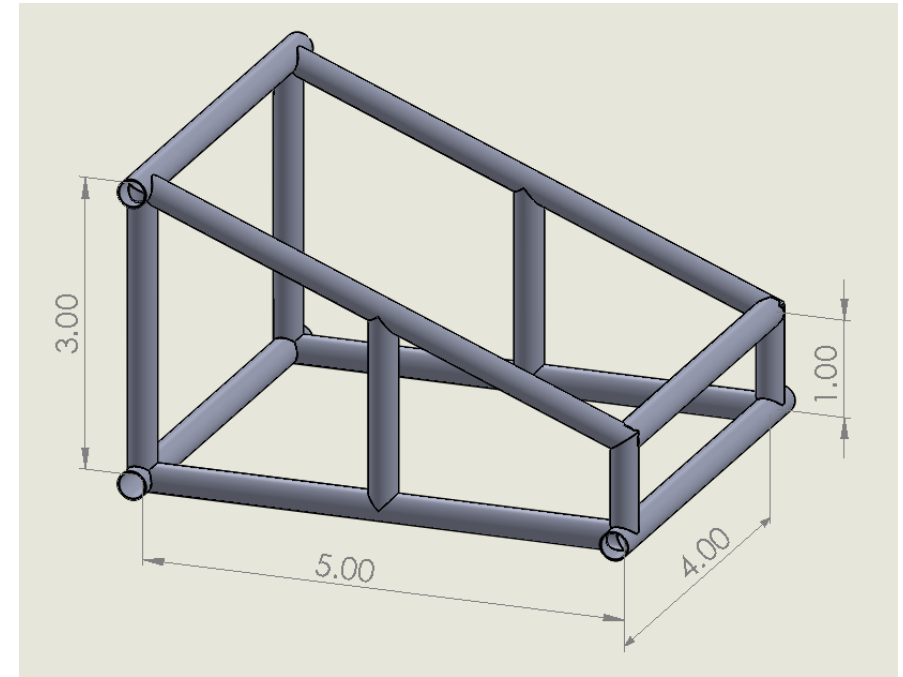


Figure 4: Design concept #2, units in feet

Analysis Techniques

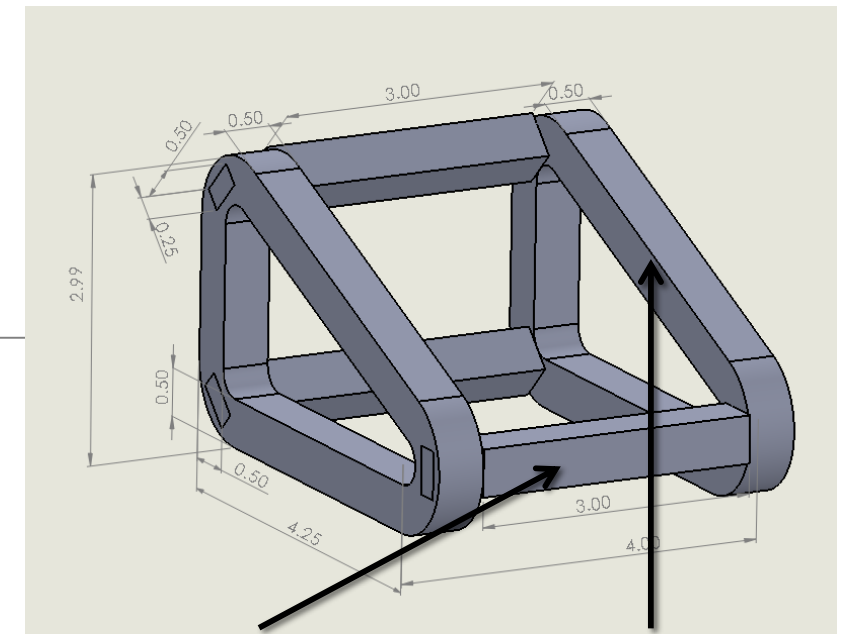
- Computer Simulation
 - Recommended by professor that simulation would be unnecessarily complicated
- Experimental Models
 - Vehicle Behavior
 - Water Effect
 - Tether Location
 - Geometry Effect



Figure 5: Flow Flume in physics building

First Models

- Base Design
 - Features such as side surfaces and holes will be added to the model throughout testing to determine the best way to keep constant orientation
 - The connectors and main surfaces are made from aluminum and press fitted together
 - Holes added for varying cable placement
- Cable for model: fluorocarbon line for ease of placement and attachment. Steel cable attached



Connector

Main Surface

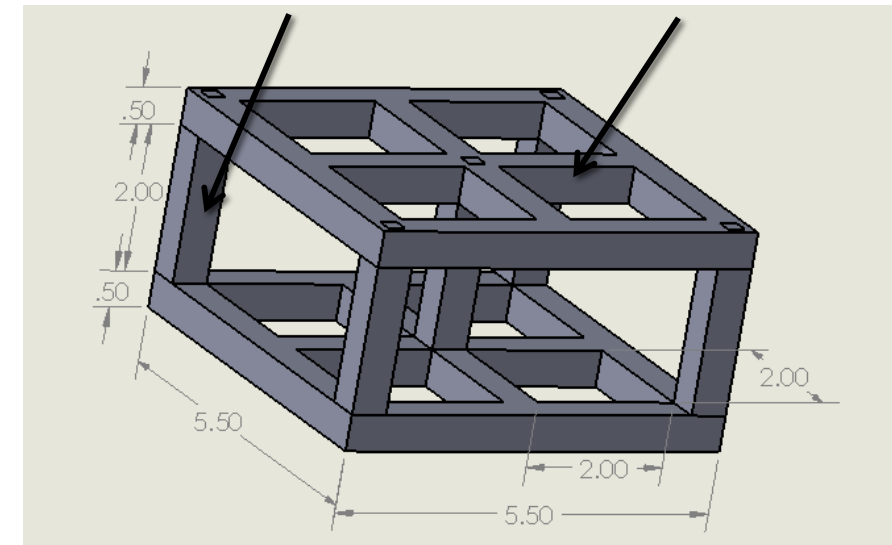


Figure 6: Square and triangular models, units in inches

Testing Models

What are we testing for?

- System Stability
- Bottom surface parallel to ocean floor
- Roll, yaw, and pitch of the structure

Optimal connection sites for tether connection

- Significant influence on rotational tendencies

Testing Models

- Model testing was qualitatively successful
- Unfortunately, these models do not give completely accurate information due to differing cross section to final model
- New models are being made
 - Circular cross section hollow piping

New models

- Steel circular hollow tubing
- Tubing size: 0.5 in.
 - Smallest available
- Made using 5.5 scale relative to final model
- Small weights with varying densities will be added to see its effect on the model
- Grid background will be added to get quantifiable data

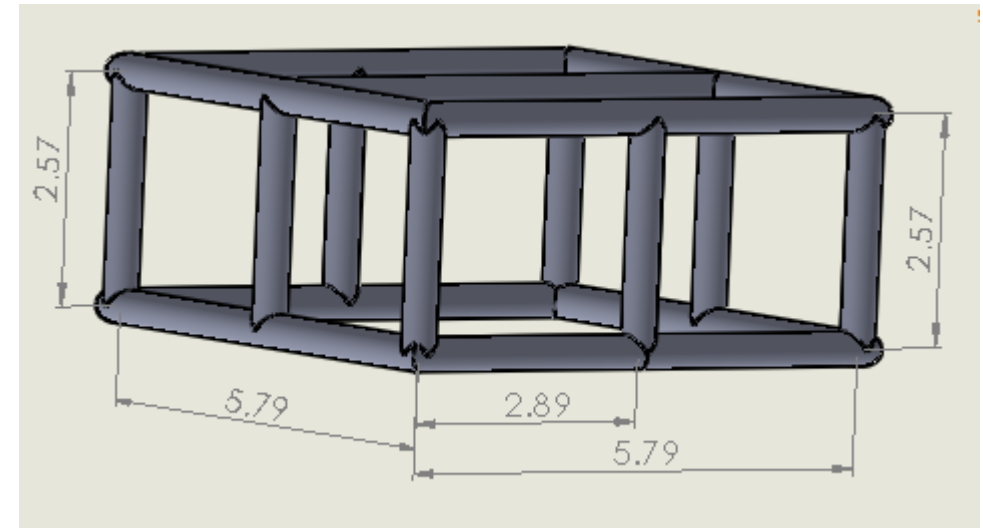
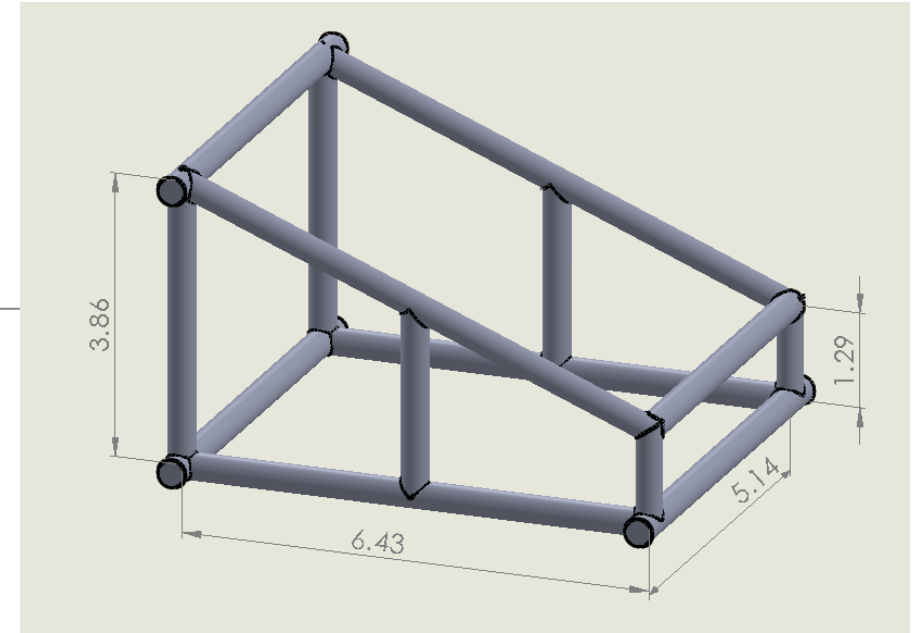


Figure 7: Square and trapezoidal models, units in inches

Force Analysis

- Total Vertical: 500 pound force
 - Components: 485 pound force
 - Aluminum Unistrut: 15 pound force
- Combined drag force of all 17 components
- Drag force calculated using equation
- Coefficient of Drag
 - Across a Cylinder: 1.2
 - Across a Rectangular Prism: 2.2
- Total drag force of 3485 Newtons, 784 pounds

$$F_{Drag} = \frac{1}{2} C_D \rho A V^2$$

Stress Analysis: Square

- Pro-E cannot perform FEA on thin walled pipe
- Wire frame with hollow beam idealizations
 - 2 - 3/8 in. OD
 - 0.203 in. thickness
- Equipment loads applied mid beam
- Drag loads applied on frontal beams
- Constraints applied at tether points
- Max stress of 580 psi
- With Aluminum 6061's yield stress, safety factor of 69

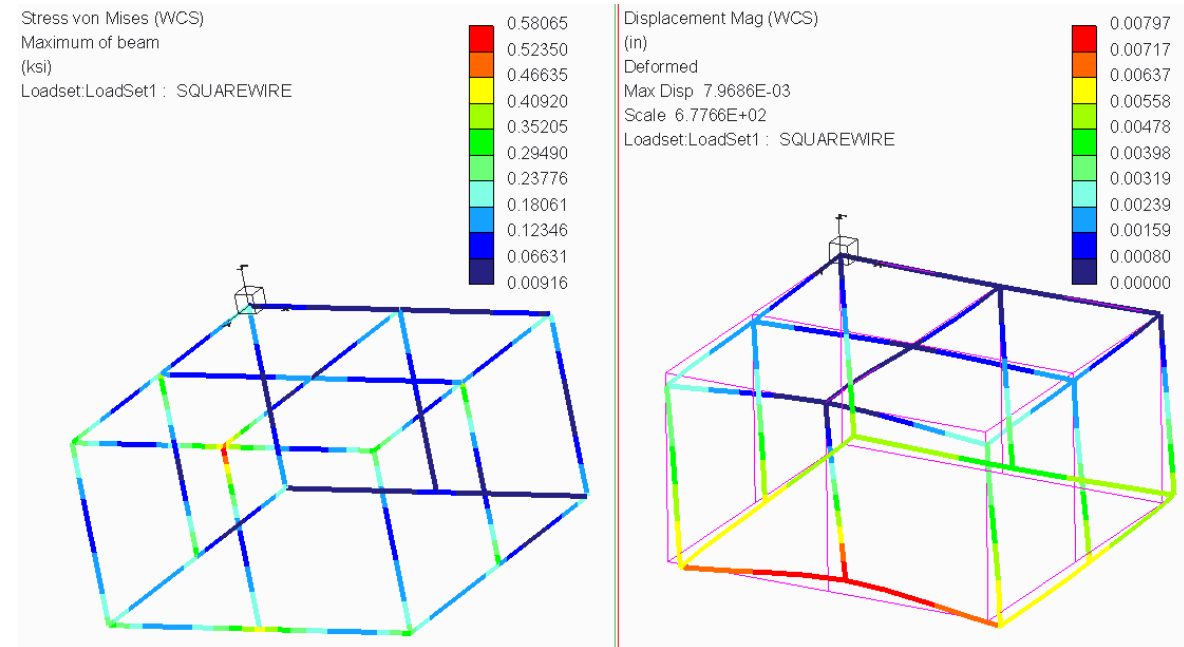


Figure 9: Stress and displacement analysis for square model

Stress Analysis: Trapezoid

- Pro-E cannot perform FEA on thin walled pipe
- Wire frame with hollow beam idealizations
 - 2 - 3/8 in. OD
 - 0.203 in. thickness
- Equipment loads applied mid beam
- Drag loads applied on frontal beams
- Constraints applied at tether points
- Max stress of 860 psi
- With Aluminum 6061's yield stress, safety factor of 47

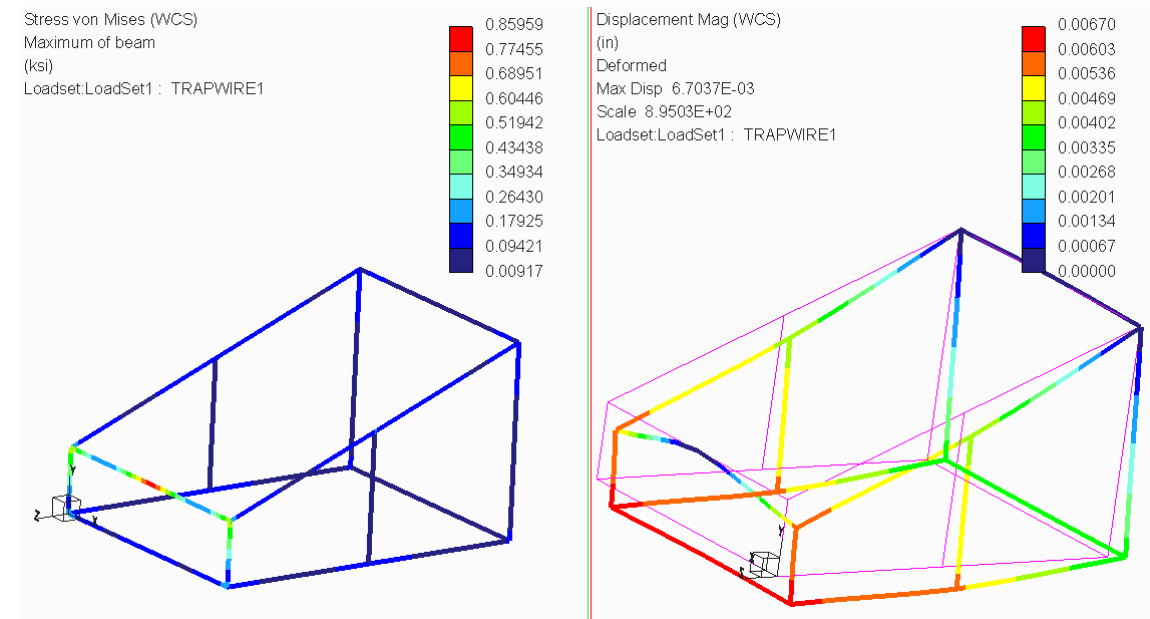


Figure 10: Stress and displacement analysis for trapezoidal model

Material Selection

- Thorough analysis was conducted to determine adequate set of materials to choose from
- Materials were excluded based on constraints of mass, ability to withstand impact, as well as hold the weight of the components and the tethered force
- Additional limitations included the isolated consideration of nonferrous materials
- Finally, a cost analysis was performed based on sizing
- This resulted in the selection of Aluminum as our structure's material

Wheels

- Necessary Specifications
 - Lockable
 - Support weight of 600+ pounds
 - Easily attachable and detachable
- Focus FTC34105HD
 - Polyurethane wheels with brake
 - 250 lbs per wheel capacity
 - 3/4" #10 x 1" threaded stem
 - \$54 for set of 4

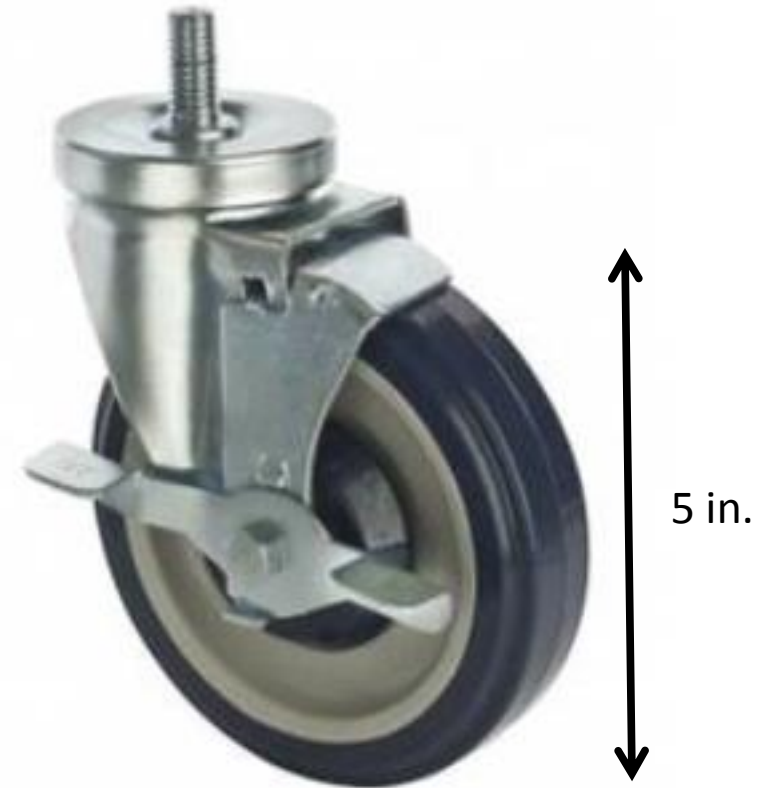


Figure 11: Possible lockable wheel to be added to the final model

Budget

- Cost of cylindrical models: \$65
- Square Model – 65 ft
 - 12 6-ft
 - 10 4-ft
 - Total: \$1352
- Trapezoidal Model – 50 ft
 - 10 6-ft
 - 5 4-ft
 - Total: \$1016
- Wheels - \$54
- Minimum Remaining Budget: \$492

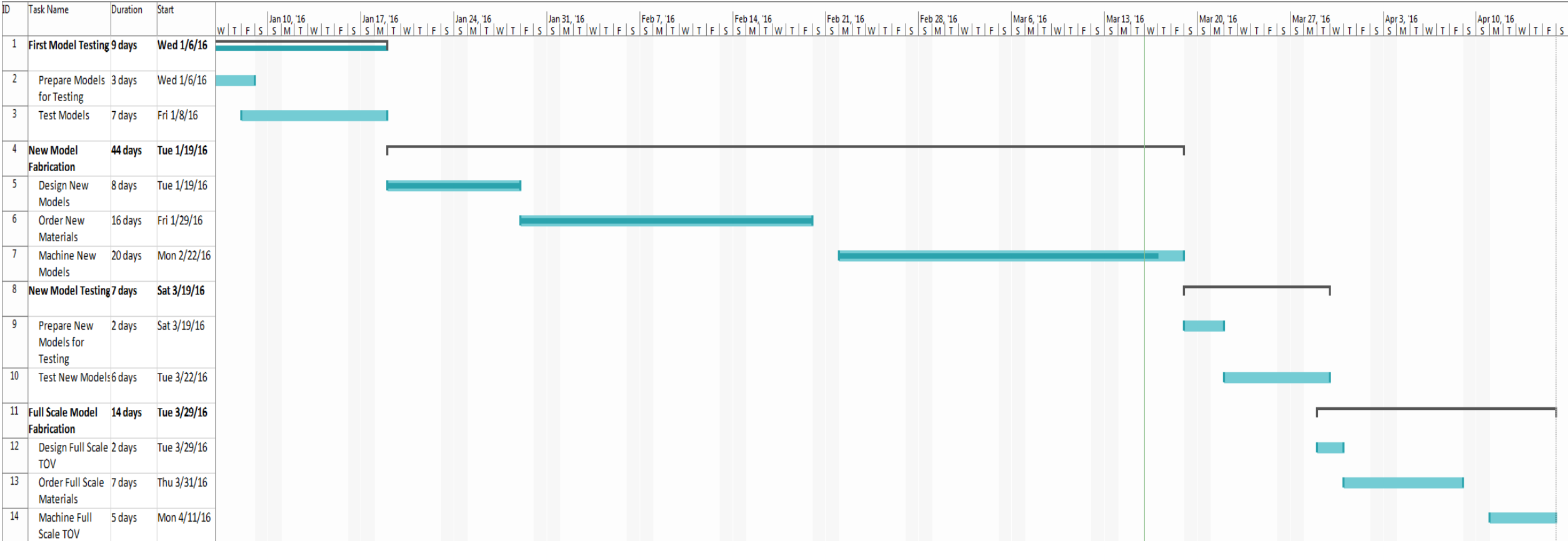
Potential Challenges

- Machining Time
- Location of cable attachment
- Mounting components in structure
- Possible Risks
 - Safety concerns during machining and assembly
 - Risk during deployment and retrieval while hanging from cable
 - Wheels: risk having large weight on wheels, could be uncontrollable on unstable boat

Future Plans

- Receive new cylindrical hollow models
- Test new models
- Choose best design
- Machine full scale design
- Attach data collecting equipment
- In water submersion test
- Application in cruise: April 25th

Gantt Chart



Conclusion

- Project Overview
 - Design new TOV
- Semester Accomplishments
 - Completion of model testing
 - Designed and began machining new hollow circular models
 - Completed stress analysis
 - Final model cost analysis
- Upcoming plans
 - Receive hollow circular models
 - New tests
 - Final Design

References

- [1] *"The Camera-Based Assessment Survey System (C-BASS) - USF College of Marine Science."* *The Camera-Based Assessment Survey System (C-BASS) - USF College of Marine Science*. N.p., n.d. Web. 24 Sept. 2015.
- [2] *"UM Scientists Help save the Day with I-Spider."* *The Daily Mississippian*. 10 Oct. 2013. Web. 24 Sept. 2015.
- [3] *"Deep-C Consortium: Voices from the Field: Geomorphology Cruise aboard the RV Weatherbird II."* *Deep-C Consortium: Voices from the Field: Geomorphology Cruise aboard the RV Weatherbird II*. N.p., n.d. Web. 24 Sept. 2015.
- [4] Macdonald, Ian. *"Asphalt in the Seep Ecosystem."* *Deep-C Consortium*. Deep-C Consortium, 2004. Web. 15 Nov. 2015. <<https://deep-c.org/news-and-multimedia/in-the-news/asphalt-in-the-seep-ecosystem>>.

Questions, Comments, or Concerns?
