Team 21: New Housing Structure for Deep Sea Equipment

Midterm 2 Presentation

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Introduction

- Tether operated vehicle (TOV)
  - Purpose is for surveying and exploration
  - 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

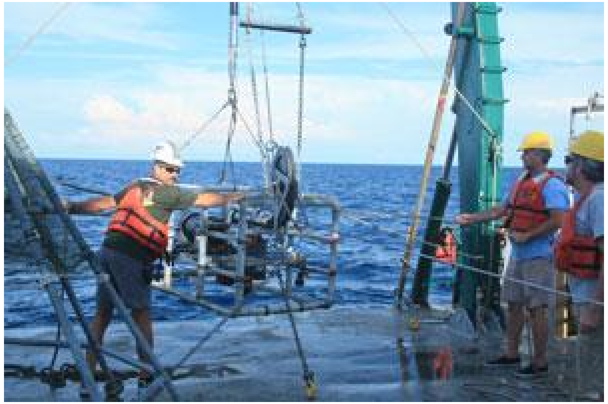


Figure 1: FSU TOV being loaded into water

Review Scope

- **Problem Statement:** Florida State University's (FSU) current tether operated vehicle (TOV) (seen in Figure 1) has too much empty space, is too heavy, is difficult to move around, and does not tow levelly.
- **Project Scope:** Update FSU's current TOV to address above issues.

Figure 2: FSU's current TOV

Objectives

Project objectives: Objectives for the updated TOV

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

Constraints

- $2,000 budget, flexible if absolutely necessary
- Corrosion Resistant
- Hold all necessary equipment
- No extra power consumption
- Modular - Components can move around the frame
- Impact resistant

Background Research

University of South Florida Design

- C-BASS (The Camera-Based Assessment Survey System), seen in Figure 2
- Operating Depth: 250 meters
- Surfaces on sides and bottom promotes a straighter tow
- Taper and smooth edges
- Modular Design
- Meets many project objectives, but only designed to operate at 250 meters

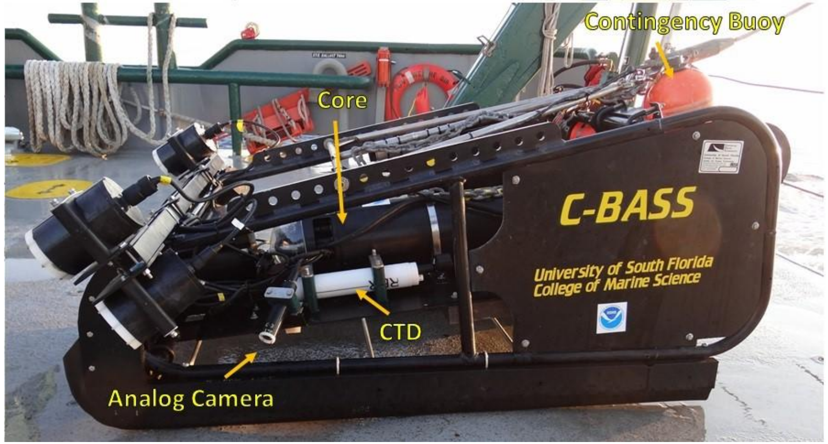


Figure 3: USF's vehicle, the C-BASS

Background Research

University of Mississippi Design

- Cylindrical Design with plenty of inside support, seen in Figure 3
- Operating Depth: 2000 meters
- Cylindrical design raises concerns with consistent orientation and footprint
- Would require much more volume for oceanography equipment

Figure 4: UM's vehicle, cylindrical shape

Customer Requirements

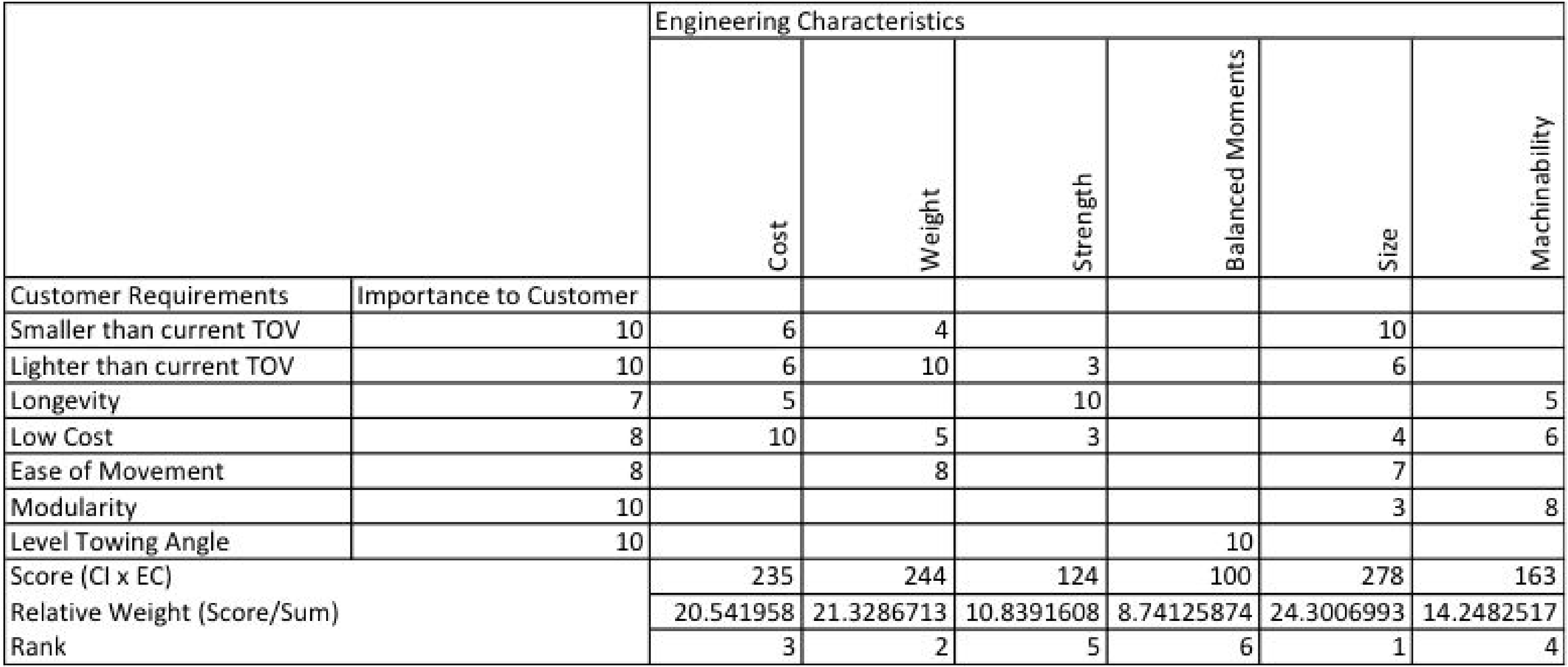
Features that the Sponsor has requested:

- Smaller than current TOV
- Lighter than current TOV
- Longevity
- Low Cost
- Ease of Movement
- Modularity
- Level towing angle

Engineering Characteristics

- Cost:
  - Project team must keep in mind the budget limitations while designing
- Weight:
  - Aim to minimize weight and keep it evenly distributed among the structure
- Strength:
  - Structure must be able to withstand the forces occurring at 2000+ meters underwater
- Balanced Moments:
  - The structure must have balanced moments in order to maintain a level towing angle
- Size:
  - Aim to minimize height to ease in deployment
- Machinability:
  - Ease of construction while maintaining structural integrity

House of Quality



		Engineering Characteristics					
		Cost	Weight	Strength	Balanced Moments	Size	Machinability
Customer Requirements	Importance to Customer						
Smaller than current TOV	10	6	4			10	
Lighter than current TOV	10	6	10	3		6	
Longevity	7	5		10			5
Low Cost	8	10	5	3		4	6
Ease of Movement	8		8			7	
Modularity	10					3	8
Level Towing Angle	10				10		
Score (CI x EC)		235	244	124	100	278	163
Relative Weight (Score/Sum)		20.541958	21.3286713	10.8391608	8.74125874	24.3006993	14.2482517
Rank		3	2	5	6	1	4

Table 1: House of Quality

Presenter: Kasey Raymo

Initial 4 Design Concepts

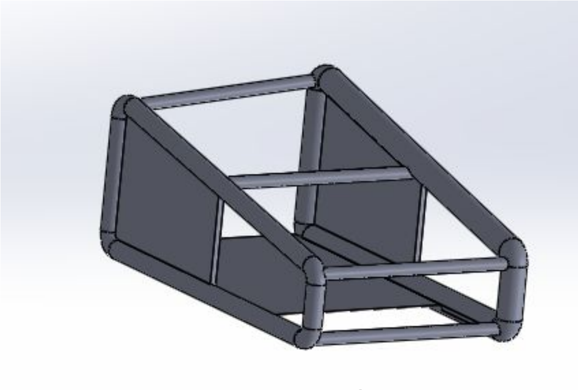


Figure 5: Design Concept 1

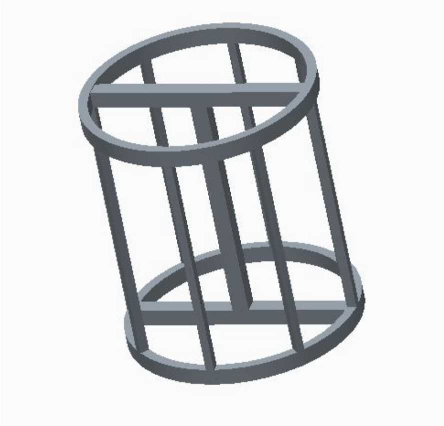


Figure 6: Design Concept 2

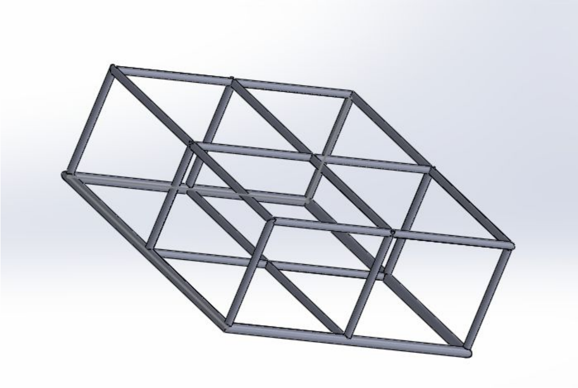


Figure 7: Design Concept 3

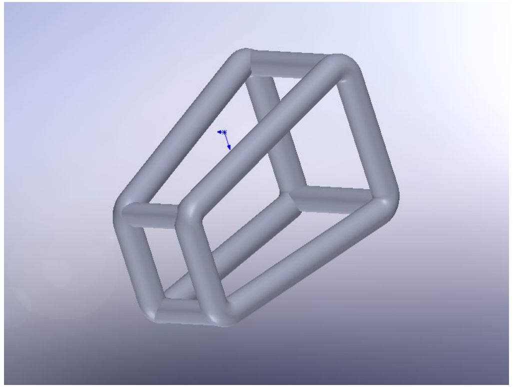


Figure 8: Design Concept 4

Eliminated Design Concepts

Advantages

- Cylindrical Design with plenty of inside support
- Open design creates less drag

Disadvantages

- Cylindrical design and possible cable connection point raises concerns with consistent orientation
- Small footprint area
- Difficult to add panels parallel to the flow without rendering much of the volume useless
- No easy way to attach cable to prevent roll

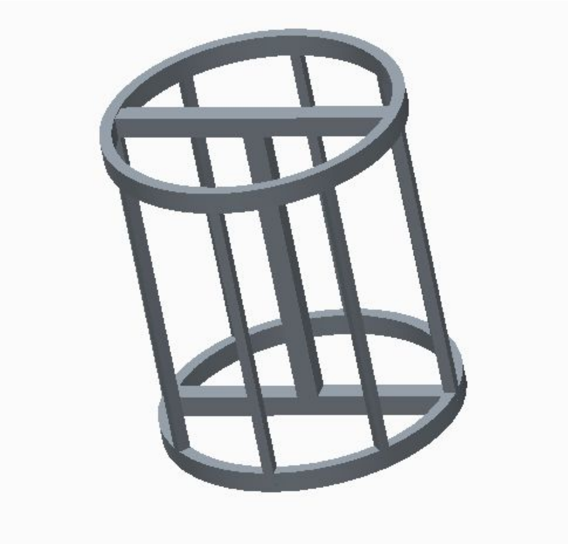


Figure 9: Eliminated design concept, #2

Eliminated Design Concepts

Advantages

- Open Design creates less drag

Disadvantages

- Difficulty distributing weight evenly
- Allowing water to flow through sides decreases the system's ability to tow straight
- Sides are tapered and not parallel to the flow
    - Addition of side panels would create excessive drag force

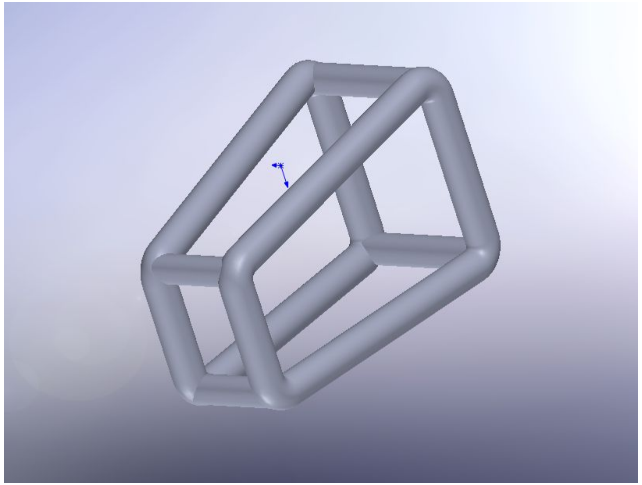


Figure 10: Eliminated design concept, #4

Remaining Design Concepts

Advantages

- Square footprint maximizes area
- Allows all equipment to have clear line of sight to ocean floor
- Low height will promote ease in deployment

Disadvantages

- Increase in footprint will lead to an increase in volume

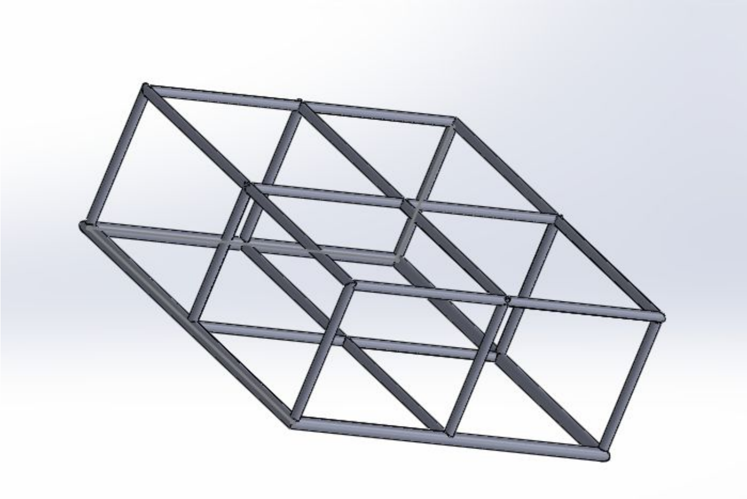


Figure 11: Remaining design concept, #3

Remaining Design Concepts

Advantages

- Surfaces on sides create drag perpendicular to flow, promoting smooth towing conditions
- Modular: equipment can be moved about the vehicle

Disadvantages

- Weight distribution could be uneven
- Not an abundance of bottom view

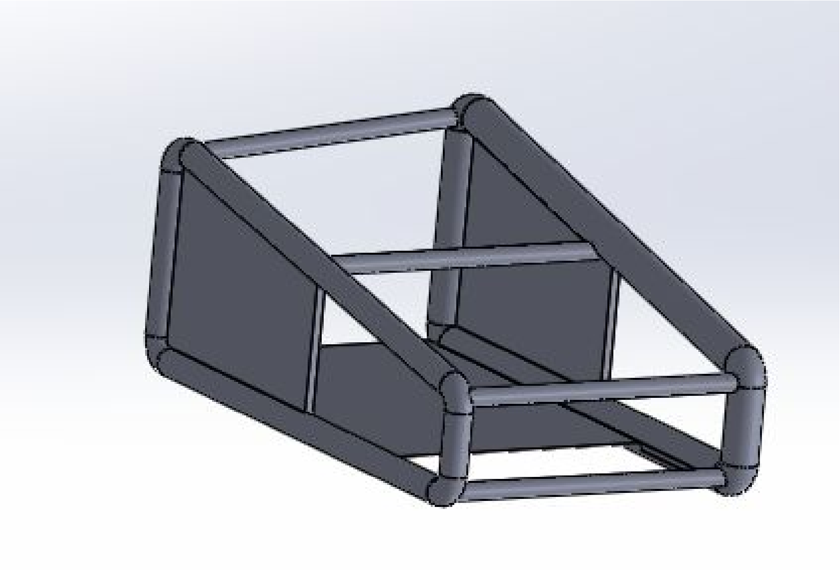


Figure 12: Remaining design concept, #1

Analysis Techniques

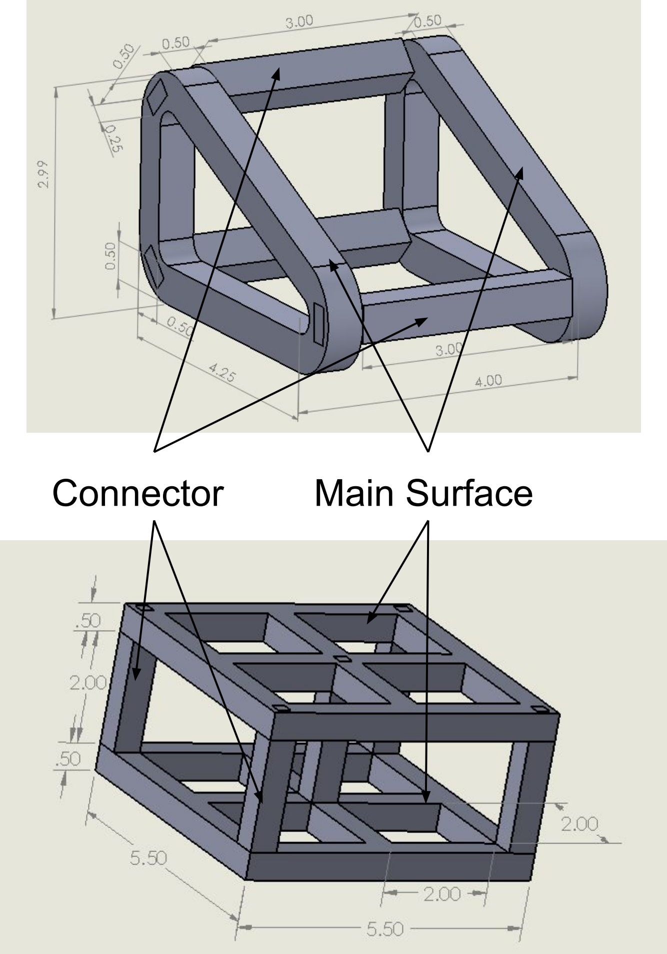
- Computer Simulation
  - Complete Force Analysis
    - Matlab
      - Forces: Gravity, Buoyancy, Lift, Drag, Tether
  - Stress Analysis
    - Pro-E

- Experimental Models: flume test
  - Vehicle Behavior
    - Water effect: current
    - Tether location effect
    - Geometry effect

Figure 13: Flow Flume in physics building

Models

- Base design
    - Features such as side surfaces, fins, and holes will be added to the model throughout testing to determine best way to keep constant orientation.
- The connectors and main surfaces will be made from aluminum press fitted together
- Simulated equipment weight using lead and styrofoam.
- Holes will be added for varying cable placement
    - Cable for model: fluorocarbon line for ease of placement and attachment. Current steel cable is too large and difficult to attach due to small model size.



Testing Models

- What are we testing for?

  - System stability
    - Bottom surface parallel to ocean floor
    - Roll, yaw, and pitch of structure
  - Best placement of simulated weight distribution
    - Where heavier and lighter equipment should be placed
  - Optimal connection site for tether connection
    - Significant influence on rotational tendencies.

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 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.

Potential Challenges

- Time
  - Ordering materials, variable shipment time
- Replicating the variable weight distribution of equipment in small models
- Location of cable attachment
- Mounting components in structure
- Determining Proper weighted system in Adams/Pro-E/Solidworks
- 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

Presenter: William Hodges

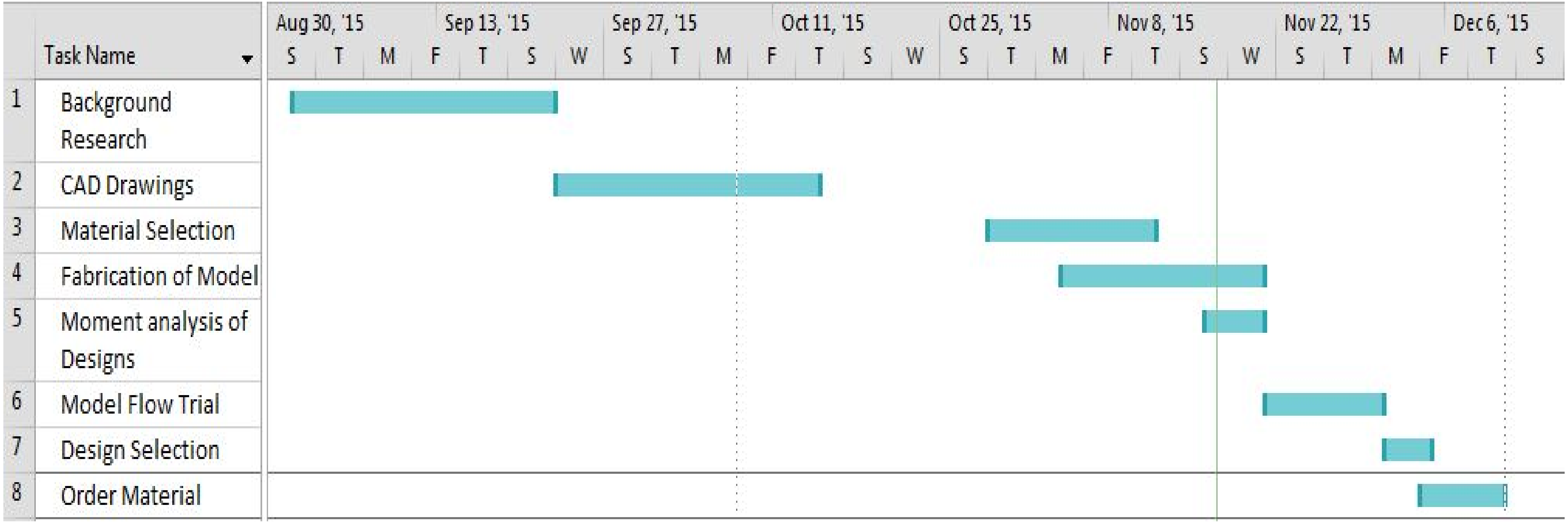
Future Plans: Short Term

- Short Term
  - Computer Aided Analysis
    - Complete Force Analysis
      - Verify forces and equations with an expert
      - Perform moment analysis to find optimal tether location
      - Simulation of forces on SimMechanics
  - Models
    - Pick up models from machine shop once completed
    - Test models in flume or pool

Future Plans: Long Term

- Long Term
  - Order Materials
    - After stress analysis, order materials -by December
  - Assembly
    - Machining
    - Attaching marine equipment to frame
  - Final Design
    - Pressure test using Civil Engineering Departments hydrostatic pressure unit
    - Full in water submersion

Gantt Chart



	Task Name
1	Background Research
2	CAD Drawings
3	Material Selection
4	Fabrication of Model
5	Moment analysis of Designs
6	Model Flow Trial
7	Design Selection
8	Order Material

Table 2: Gantt chart outlining future plans for the project

Conclusion

- Background Research
- Engineering Characteristics and Customer Needs
- Design Concepts
    - Narrowed down to 2 designs
- Future Plans
    - Complete force analysis to find optimal tether location
    - Test scaled-specimen in flow flume once models are completed
    - Select best geometry
    - Order materials and assemble final design
    - Test final design under large pressures

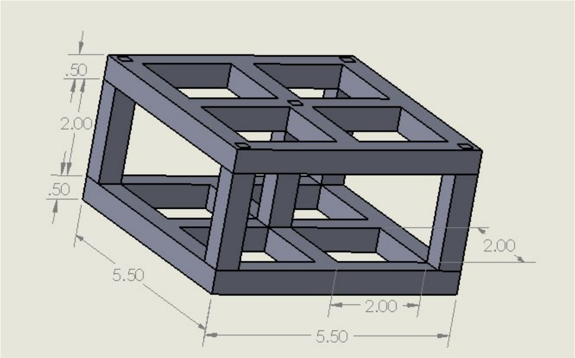


Figure 16: Model #1

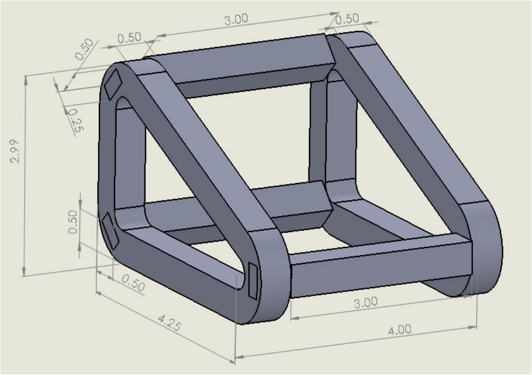


Figure 17: Model #2

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?