Team 21:New Housing Structure for Deep Sea Equipment

Earth, Ocean and Atmospheric Science

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October 20, 2015

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 cannot be oriented once submerged.
- **Project Scope:** Update FSU's current TOV to address above problems.

Figure 1: 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

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 creates a more hydrodynamic shape
- Modular Design
- Meets many project objectives, but only designed to operate at 250 meters

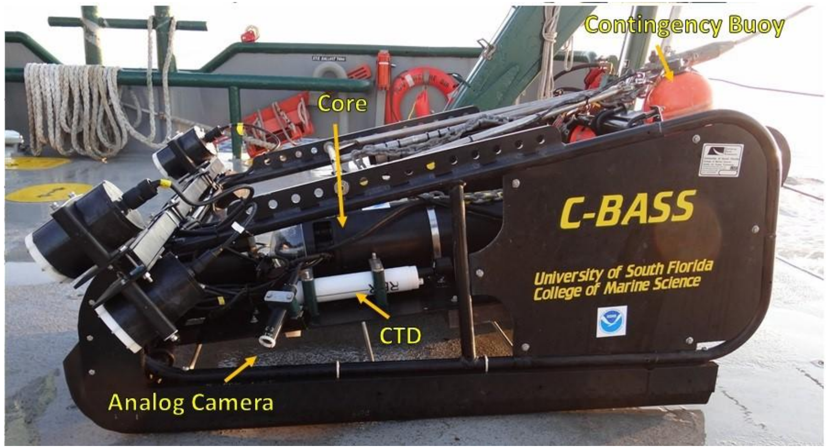

Figure 2: USF's vehicle, the C-BASS

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 3: UM's vehicle, cylindrical shape

Customer Requirements

Features that the Sponsor has requested:

- Smaller than current TOV
- Lighter than current TOV
- Longevity
- Corrosion Resistance
- Pressure Resistance
- Low Cost
- Ease of Movement
- Modularity
- Orientation ability
- 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
- Hydrodynamic:
  - The structure must be hydrodynamic to tow smoothly in the water
- 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	Hydrodynamic	Size	Machinability
Customer Requirements	Importance to Customer						
Smaller than current TOV	10	6			6	10	
Lighter than current TOV	10		10		6	6	
Longevity	7			10			3
Water Resistance	10						10
Low Cost	8	10				4	6
Ease of Movement	8		8		7	7	7
Modularity	10		3				8
Orientation Ability	4	7	3		7		
Level Towing Angle	6				10		
Score (CI x EC)		168	206	70	264	248	305
Relative Weight (Score/Sum)		13.3227597	16.3362411	5.55114988	20.9357653	19.666931	24.1871531
Rank		5	4	6	2	3	1

Table 1: House of Quality

Design Concept 1

USF Inspired Design

Advantages

- Hydrodynamic shape promotes smooth towing
- Surfaces on sides and bottom also promote smooth towing conditions
- Modular: parts can be moved about the vehicle

Disadvantages

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

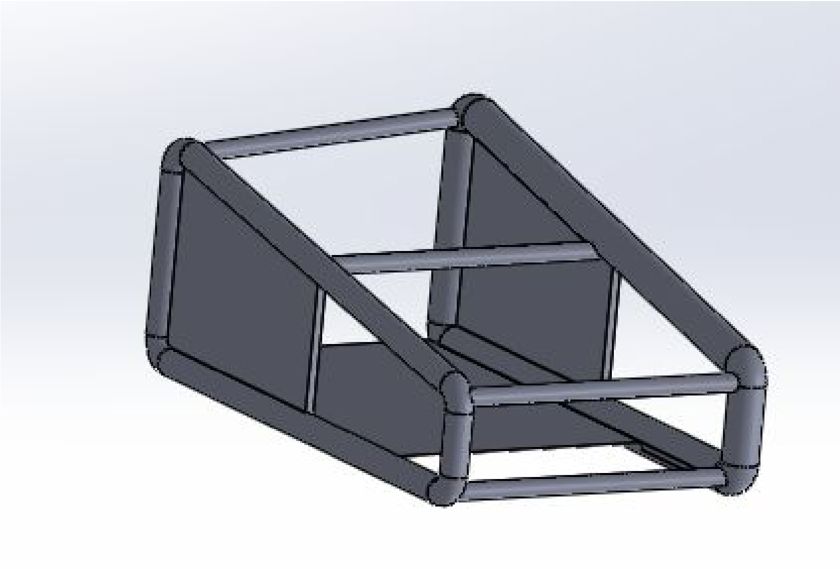

Figure 4: Design Concept 1

Design Concept 2

University of Mississippi Inspired Design

Advantages

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

Disadvantages

- Cylindrical design and singular cable connection point raises concerns with consistent orientation
- Small footprint area

Figure 5: Design Concept 2

Design Concept 3

Suggested by one of the sponsors, Eric Howarth

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

- Blunt shape is not hydrodynamic
  - Possible surfaces within system may counteract this issue
- Increase in footprint can lead to an increase in volume

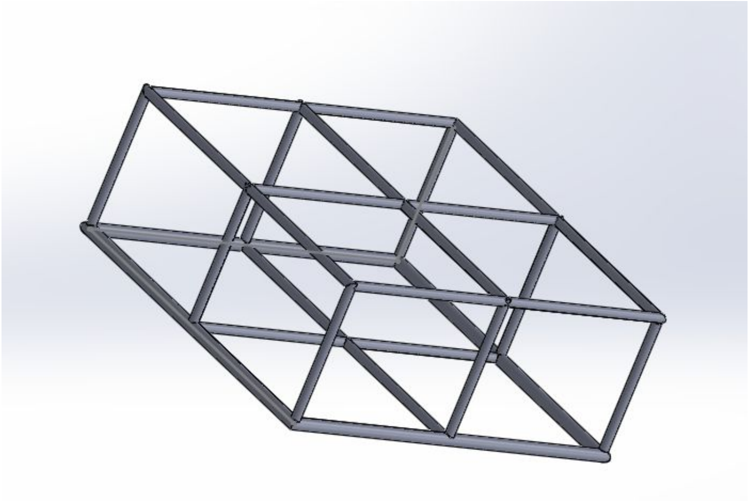

Figure 6: Design Concept 3

Design Concept 4

Suggested by other sponsor, Dr. Ian MacDonald

Advantages

- Tapers towards front increasing hydrodynamic quality
- Open Design creates less drag

Disadvantages

- Difficulty distributing weight evenly
- Allowing water to flow through sides decreases the system's ability to tow straight

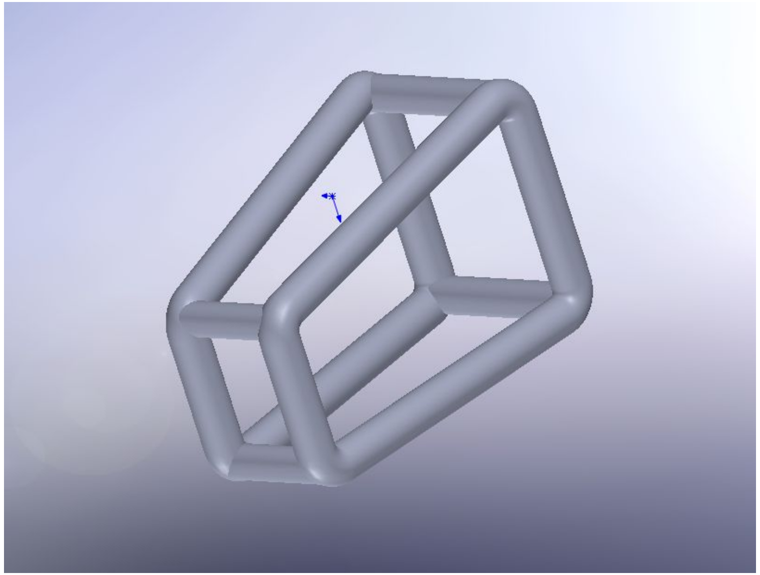

Figure 6: Design Concept 4

Concept Evaluations

- Using a Pugh Matrix, current evaluation techniques yield a ranking of:

1. C-BASS Inspired
2. Tapered Design
3. Square Footprint
4. University of Mississippi inspired

Criteria	Base	Design 1	Design 2	Design 3	Design 4
Cost	3	1	1	1	1
Weight	1	1	0	-1	-1
Hydrodynamics	4	1	0	-1	1
Footprint	5	0	-1	1	0
Height	2	0	-1	1	0
Machinability	3	0	-1	1	0
Longevity	5	1	-1	-1	0
Safety	5	1	1	1	1
Sum of Positives		18	8	18	12
Sum of Negatives		0	-15	-10	0
Sum of Neutrals		0	0	0	0
Total		18	-7	8	12

Table 2: Pugh Matrix deciding best design concept

Analysis Techniques

- Computer Simulation
  - Adams
    - Force analysis
  - Pro-E/SolidWorks
    - Stress analysis
  - Matlab
    - Moment and Centroid analysis
- Experimental Models: flume test
  - Vehicle Behavior
    - Water effect: current
    - Tether effect
    - Geometry effect

Figure 7: Flow Flume in physics building

Potential Challenges

- Time
  - Ordering materials, variable shipment time
  - Must be completed for cruise in February
- Replicating the variable weight distribution of equipment in small models
- Determining Proper weighted system in Adams/Pro-E/Solidworks
- Possible Risks
  - Safety concerns during 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: Short Term

1. Short Term
    a. Computer Aided Design
        i. Create current models in Adams
            1. Add forces, possibly changing forces with changing environment
            2. Determine stress on structure
        ii. Matlab
            1. System of equations on housing unit
            2. Additional axis analysis
            3. Simulation of forces on SimMechanics
        iii. Material Selection
            1. Optimal material that minimizes weight while maintaining sufficient strength
            2. Sponsor suggestion: 6061 Aluminum
    b. Models
        i. Metals for structure of model: aluminum, steel
        ii. Possible materials to scale the weight of inside components: lead, styrofoam
        iii. Machine models

Future Plans: Long Term

1. Long Term
    a. Order Materials
        i. After stress analysis, order materials (by end of first semester)
    b. Assembly
        i. Machining
        ii. Attaching marine equipment to frame
    c. Final Design
        i. Pressure test using Civil Engineering Departments hydrostatic pressure unit
        ii. Full in water submersion

Gantt Chart

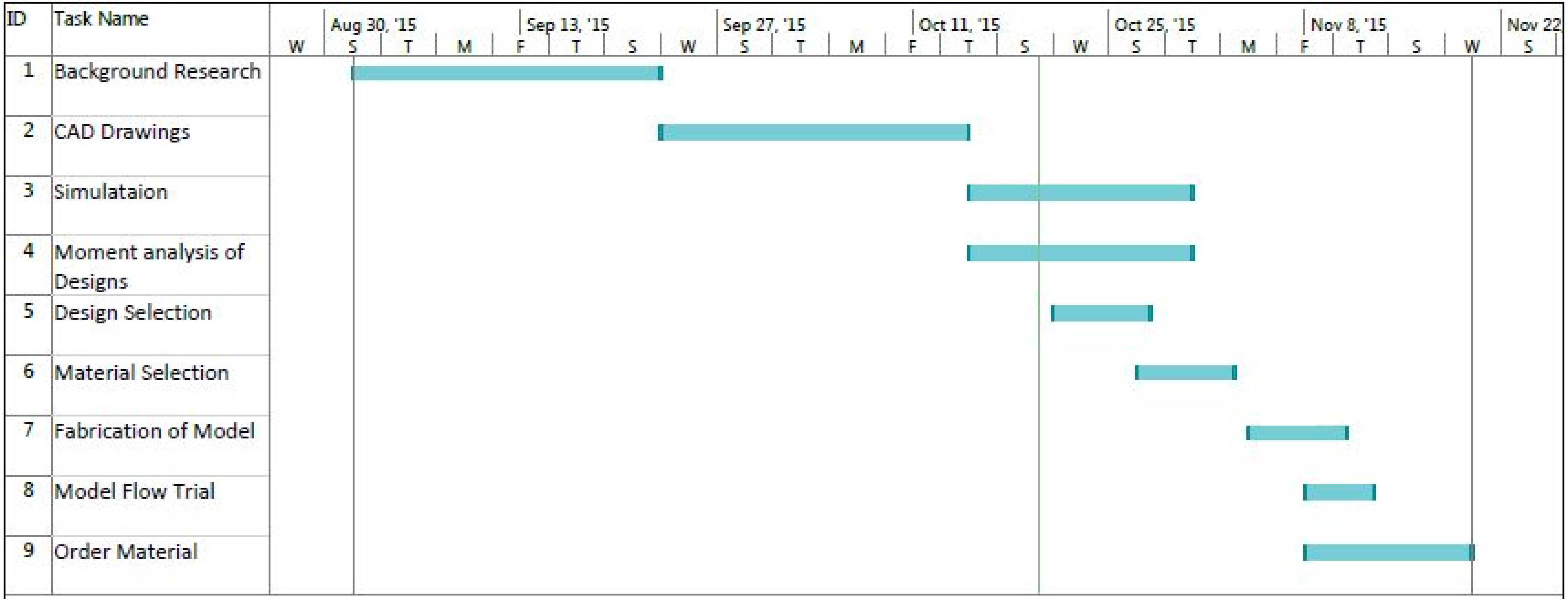

Table 3: Gantt chart outlining future plans for the project

Conclusion

- Background Research
- Engineering Characteristics and Customer Needs
- Design Concepts
  - Narrowed down to 4 designs
- Design Selection
  - Design Selection was done using Pugh matrix
  - Design 1 best meets the customer needs and engineering characteristics
- Future Plans
  - Simulate flow conditions using software to observe how vehicle will behave
  - Test a scaled-specimen in flow flume
  - Materials selection based off of stress analysis
  - Order materials and assemble final design
  - Test final design under large pressures

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.

Questions, Comments, or Concerns?