Restated Project Definition and Project Plan/Scope

EML4552C - Senior Design - Spring 2016

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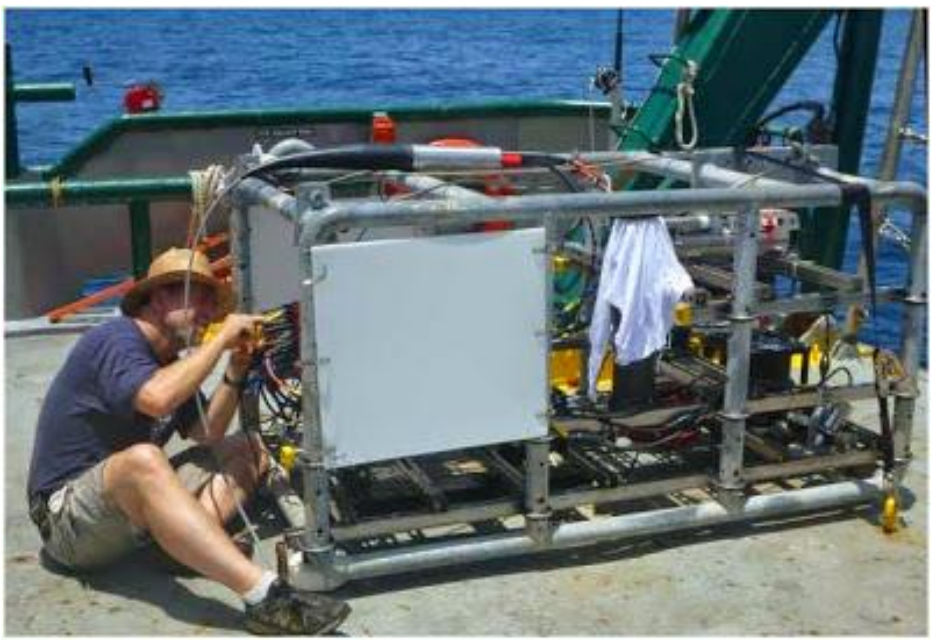
Team 21 - New Housing Structure for Deep Sea Equipment

Sponsor: The Earth, Ocean, and Atmospheric Science (EOAS) group at Florida State University

Faculty Advisor: Dr. Camilo Ordonez



Group Members:

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1- Introduction

The Earth, Ocean, and Atmospheric Science (EOAS) group at Florida State University is interested in updating their current aquatic tethered operated vehicle (TOV) to a smaller, lighter, more modular, levelly oriented, and easily moveable design. The design currently is a 3 feet by 3 feet by 6 feet rectangular prism with 17 pieces of equipment attached to collect data and house necessary electronics. This TOV needs to be able to withstand pressures of 2000 meters deep and be impact resistant in case of collisions with rocks on the ocean floor. In order to do this, research must be done on previous TOVs and the best aspects from each - i.e: shape, inside design, material - can be implemented into our design. To determine an optimal volume and equipment set up within the housing, there must be a standardization when analyzing the potential designs.

2- Problem statement

The sponsor for this Modular Instrument Lander and Equipment Toolsled v2.0 (MILET-2) project is the EOAS group at Florida State University. Currently, they have a TOV. Their TOV is 6 feet long, 3 feet wide, and 3 feet tall and is made of galvanized steel piping. Many sensors, cameras, lights, and lasers have the ability to attach to the TOV. The TOV is currently able to be pulled behind a boat via a tether and collects data at a depth of about 2,000 meters under water. The current TOV has too much empty space, is too heavy, is difficult to move around, and does not tow parallel to the ocean floor.

3- Project Scope/ Goal

As aforementioned, the problems with the current TOV is that it has too much empty space, is too heavy, is difficult to move around, and does not tow parallel to the ocean floor. In order to fix these issues, an analysis in cost, optimal shape, and materials has been completed and will be implemented. Conclusively, the design will be an improved TOV frame that is smaller, lighter, more modular, and tows with a consistent orientation parallel to the ocean floor.

4- Project Objectives

In order to update the TOV, the main project objectives will be focused on as:

- Reduce the weight and size of the new frame
- Design a modular frame in that the data collecting equipment can move about the frame
- Must be easier to transport and manipulate
- Design the new frame so that it tows parallel to the ocean floor

5- Overall plan/Methodology/Approach

Initially the most important aspect of the project was to get an in depth understanding of what was needed. This includes gathering information on the deep sea data collecting equipment that the EOAS group currently utilizes, such as weight and dimensions. A house of quality (HOQ) diagram, located on table 1 on the following page, was created to determine the most important engineering characteristics to keep in mind during the design and analysis of the project: cost, weight, strength, balanced moments, size, and machinability. Because this project is redesigning the housing structure, cost, weight, strength, and machinability can be considered as individual components of a materials property to help in determining the best material. The other two components, balanced moments and size, are associated with the structural design. The HOQ ranked the most important engineering characteristics as size, followed by weight, cost, machinability, strength, and balanced moments. Since two customer requirements were to decrease weight and maximize the footprint area while reducing the volume, it makes sense that size and weight were ranked as the top two engineering characteristics.

Table 1: House of Quality Diagram for MILET-2

		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

Once the HOQ was finished, extensive background research was done to understand previous designs and how these designs performed underwater using moment, drag, and centroidal analysis. The best aspects of each design were determined, and were integrated with personal designs. When a computer simulation was roughly designed, it was unknown what magnitude and direction of forces that the towing cable would create, since 2,000 meters down the cable has unknown dynamics. After receiving advice from multiple professors in the field, it was agreed that experimental analysis would be the best option due to time constraints.

Upon the completion of background research, analysis was done to come up with geometries for the new frame. The analysis took into account the volume, footprint area, frontal area, geometry of piping, and weight distribution effect. A material analysis was also done to determine the optimal material to use on the full scale model. After the sponsors approved these new designs and problems that arose were fixed, a smaller scale model of each geometry was built to test how the shape will behave while being towed in large depths, simulated using a testing flume in the Florida State physics department. These experiments are currently being conducted. Again, any issues that arise will be fixed. Once the models are tested and the best geometry is chosen, a final design will then be built and tested in St. Petersburg.

6- Project Constraints

Speaking to the sponsors, it was clear there was a number of constraints which must be kept in mind:

- The total cost may not exceed $2,000 (additional funding available if proven necessary)
- Must be modular in the sense that components may move about the frame
- Made of corrosion resistant materials
- Ability to hold all necessary equipment
- The frame must be pressure resistant (minimum of 2000 meters)

- Must not consume any more power than original design

7- Deliverables

Illustrated below is Team 21's Gantt chart. This provides the breakdown as a timeline with specific tasks that are left to be completed during this final semester. The lengths of the bars are indicative of the duration of each task.

This gantt chart has been updated because the group is slightly behind schedule. Within the next couple of weeks the group must finalize testing, choose a geometry based off of this testing, order the material necessary to create a full scale version, and have the full scale structure machined and assembled. After it is assembled, it will be tested under high pressures in the civil department's hydrostatic pressure unit. There will also be an in water submersion test after all of the data collecting components have been attached to the frame. If all of the testing goes well, the structure should be ready for the cruise that the EOAS group has planned at the end of Spring semester.

Table 2: Gantt Chart Outlining Future Work for Design Project

Complete Model Testing

Choose Geometry

Create Drawings for Full Scale Structure

Order Material

Machine/Assembly

Pressure Testing

In Water Submersion Testing

Component Attachment

Application in Cruise

8- Assign resources

Because this team only has 3 members, it was decided as a team to do most of the work together. The model testing has been a group effort and has not been allocated to one group member. Some of the conceptual design tasks, though, had been broken up between the members and can be seen below:

- William: Material analysis for various materials on the weakest member of the frame. Also performing cost analysis on these materials.

- Kasey: Created the drawings for the miniature models that were submitted to the machine shop for fabrication and assembly.

- Chelsea: Created the drawings for the full size models that will be utilized once a decision has been made on the best geometry.

9- Product Specifications

Below are specifications pertaining to the design and the performance of the MILETv2.

9 A Design Specifications

- Geometric dimensions and tolerances: In order to accurately determine the best dimensions, the team chose possible designs that created a sufficient footprint area while making the volume smaller than the original TOV.
- Static: A material stress analysis for the structure was done based on the equipment placement within it and pressure forces that will act on the structure.
- Dynamic: An experimental analysis is in the process of being completed to determine how underwater forces affect the behavior of the structure. Many variables are being taken into account, such as tether connection point location and number of tether connection points to determine the combination that promotes the straightest tow.
- Weight: Since this system will be both underwater and above water, a weight calculation needs to be done for both mediums. The team is trying to keep the weight of the new structure to a minimum.
- Equipment Integration within the design system: the equipment will be placed in a manner that evenly distributes the weight as much as possible because the testing is being done under those conditions, this will keep the system the most stable underwater.

9 B Performance Specifications:

- Water Resistant: The structure must will be utilized at great ocean depths so its material must be resistant to rust and wear from the salt water.
- Level towing angle: Must cruise at a constant level angle so that the bottom of the frame is parallel to the bottom of the ocean floor.
- Modular: Data collecting equipment must be able to move about the frame .
- Easy to transport: The new frame must be easier to transport long distances than the original frame. This includes being generally smaller and lighter than the original vehicle.
- Resistant to pressures occurring at 2000+ meters: The vehicle's operating depth is approximately 2000 meters so the new frame must be able to resist the large forces that occur due to the water pressure.
- Holds all data collecting equipment: The new frame must have a large enough volume and footprint to hold all data collecting equipment and a large enough footprint to allow the necessary pieces of equipment to have a clear view of the ocean floor.

- Power Consumption: All actuators added to the new frame must not consume any more power than the original frame.

Conclusion Do we need one?

Similar to last semester, the problem statement, constraints, and solution approach to the project have not changed. However, the timeline for completion as well as completed work have changed. The final project should be completed by the end of spring semester rather than February. Also, the experimentation phase has begun which includes model testing in bodies of water.