Deliverable #2: Project Plan and Product Specification

EML4551C - Senior Design - Fall 2015

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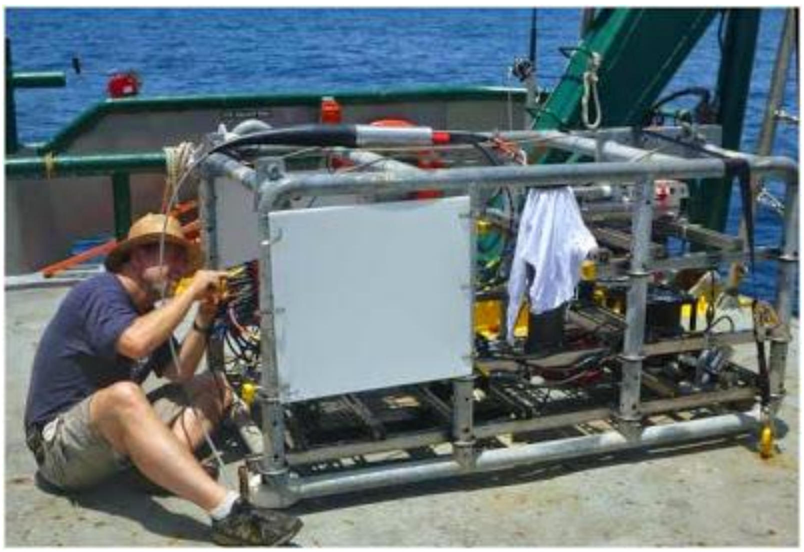
Team 21 - New Housing Structure for Deep Sea Equipment

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

Faculty Advisor: Dr. Camilo Ordonez



Group Members:

Hodges, William R. - Team Leader

Dodge, Chelsea - Lead ME

Raymo, Kasey - Financial Advisor

Table of Contents

Table of Figures

Table of Tables

1- Problem statement

The sponsor for this Modular Instrument Lander and Equipment Toolsled v2.0 (MILET-2) project is the Earth, Ocean, and Atmospheric Science (EOAS) group at Florida State University. Currently, they have a tether operated vehicle (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 2000 meters under water. The current TOV has too much empty space, is too heavy, is difficult to move around, and cannot be oriented once submerged.

2- 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 cannot be oriented once submerged. In order to fix these issues, an analysis in cost, optimal shape, and materials will need to be completed and implemented. Computer simulations in MatLab will not only help with determining the best shape, but will also help with plotting the changing underwater forces acting on the system. Conclusively, the design will be an improved TOV frame that is smaller, lighter, more modular, and has the ability to be oriented underwater.

3- Project Objectives

The main project objectives:

- Reduce the weight and size of the new frame
- Design a modular frame
- Must be easier to transport and manipulate
- Have an orientation system

4- Overall plan/ Methodology/ Approach

Initially the most important aspect of the project is to get an in depth understanding of what is needed. This includes gathering information on equipment such as weight and dimensions. A house of quality (HOQ) diagram, 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, hydrodynamic, 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, hydrodynamic (including both shape and passive actuators) and size, are associated with the structural design. Because the modularity and how the system moves underwater was originally thought to be the most important aspects of this project, it came to no surprise when machinability (important aspect of modularity) and hydrodynamic (underwater movement) ranked as the top two most important. Finally, the HOQ ranked the most important engineering characteristics as machinability, followed by hydrodynamic, size, weight, cost, and strength.

Table 1: House of Quality Diagram for Design Project

		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

Once the HOQ was finished, extensive background research must be done to understand previous designs and how these designs performed underwater using moment, drag, and centroidal analysis. When the best aspects of each design are determined, they will be integrated with personal deigns to determine the best design possible for this project. After background research is finished, new designs need to be drawn and have its own analysis done similar to the previously mentioned analysis in the *Project Scope/Goal* section. After the sponsors approve these new designs and problems that arise are fixed, a smaller scale model will be built to test how the shape will behave while being towed in large depths in a tank in the lab. Again, any issues that arise will be fixed. Once the models are tested and the best geometry is chosen, an optimal material will be chosen for the vehicle's purpose. A final design will then be built and tested in St. Petersburg.

5- Project Constraints

Constraints:

- The total cost may not exceed $10,000
- Must be modular
- 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

6- Deliverables

On the next page in figure 1, one can see the Gantt chart that was created. This Gantt chart organizes the various tasks that need to be completed up until the end of the semester. By the end of this semester the material for the new structure should have been ordered so it will be ready to machine and assemble when the team returns for spring semester.

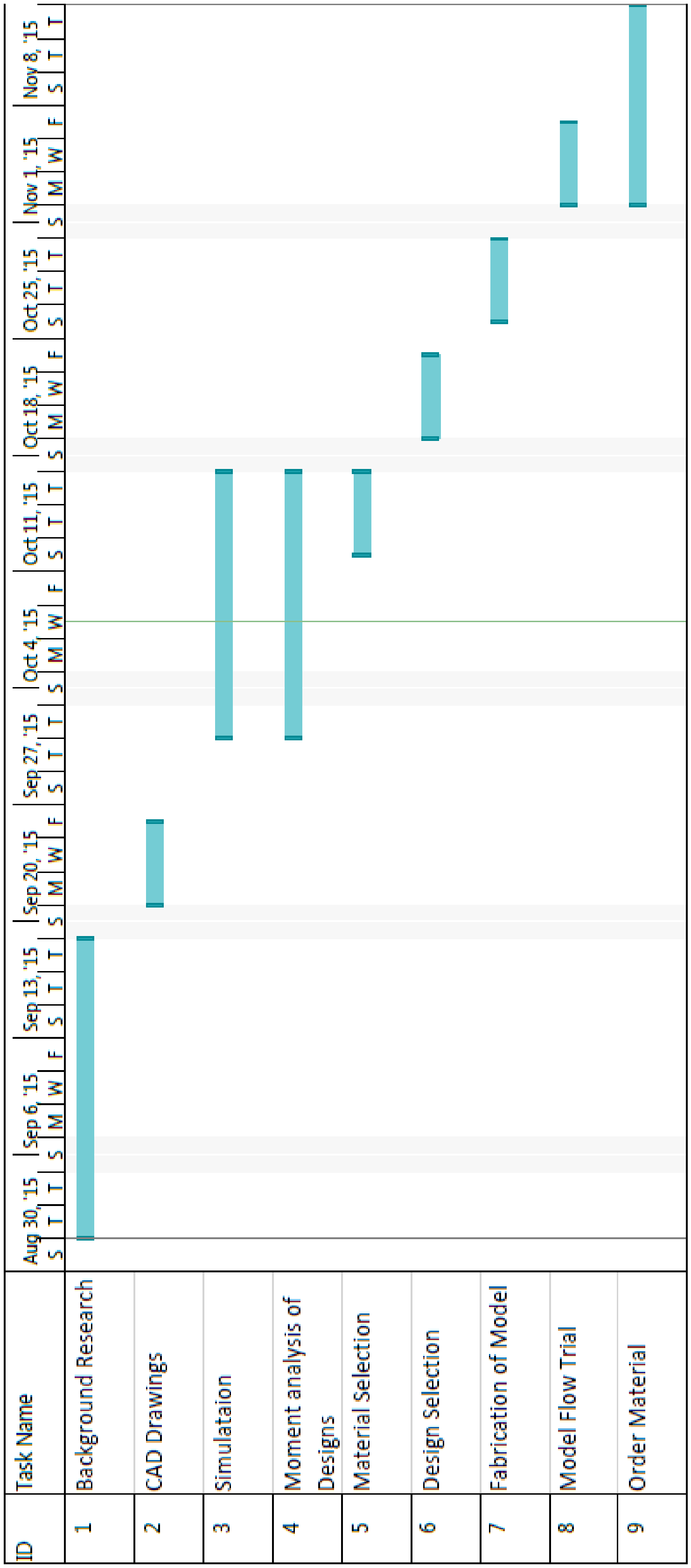


Figure 1: Gantt Char for Design Project Timeline

7- Assign resources

Because this team only has 3 members, it was decided as a team to do most of the work together, though some of the conceptual design tasks have been broken up between the members below:

- William: Material and Cost analysis
- Kasey: Centroidal analysis
- Chelsea: Simulation

8- Product Spec

Below are specifications pertaining to the design and the performance of the MILETv2.0.

8- A Design Specifications

- Geometric dimensions and tolerances: In order to accurately determine the best dimensions, a simulation to optimize the volume with the necessary equipment will be written using MatLab. Tolerances will be later determined using error techniques and added into the simulation.
- Static: A material stress analysis for the structure will be done based on the equipment placement within it and pressure forces that will act on the structure.
- Dynamic: A structural analysis based on how underwater forces affect the structure in a material deformation aspect as well as how the structure will behave underwater will be done. This can be done through simulation in order to continuously change design conditions.
- Weight: Since this system will be both underwater and above water, a weight calculation needs to be done for both mediums. This can be done by adding systems components together when they're underwater and when they're above water.
- Equipment Integration within the design system: Depending on the centroidal analysis, the components will be put in to keep the system the most stable.

8- 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 removable from the frame in addition to the frame having the ability to break down into components.

- Easy to transport: The new frame must be easier to transport long distances than the original frame. This includes the ability to be broken down into smaller components and 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.