Creator: Chris McLean
Date: 09-04-16
Project: RoboSub
Full Project Title: RoboSub Team Killick

TEAM

PROJECT TEAM

Name	Title	Department	Project Role
Brett Gonzales		ECE	Sensor Subteam
Tyler Loughrey	Chief Financial Officer	ECE	Sensor Subteam
Chris McLean	Team Lead	ECE	Propulsion Subteam
Phil Meister		ECE	Propulsion Subteam
Nate Marquez		ME	Mechanical Subteam
Seth Purkey		ME	Mechanical Subteam
Mitchell Yohanan		ME	Mechanical Subteam
Marta Camacho		ECE	VIP
Oren Pierce		ECE	VIP
Billy Phillips		ECE	O2P

INDUSTRY MENTORS

Name	Company
Dr. Jake Sauer	Ball Aerospace

PROJECT CHARTER APPROVALS

Name	Role	Signature	Date
Dr. Tony Maciejewski	Project Supervisor		

REVISION HISTORY

Name	Comments	Version	Date
Chris McLean	Charter creation	1.0	9/12/2016
Phil Meister	Charter revision	1.1	9/15/2016

1. PROJECT OVERVIEW

1.1 PROJECT SUMMARY

The RoboSub project is to form an evolutionary senior design program at CSU in designing, implementing, testing, and competing with autonomous underwater vehicle (AUV) in cooperation with the United States Navy RoboSub competition.

This project has three aspects: motors/controls, sensing/processing, and mechanical. Two EE's will focus on construction, implementation, and testing of motors and controls while one EE and one CE will focus on the image processing and sensing necessary for navigation. The three ME's will focus on design, implementation, and testing of vehicle exoskeleton, propulsion requirements, and overall water suitability of the vehicle. Further team participants include up to 5 undergraduates to learn, develop, and eventually evolve the RoboSub project.

1.2 IMPORTANCE OF PROJECT

The scope of the RoboSub competition is highly technology oriented. This gives a strong academic value to RoboSub as it engages undergraduates from mechanical, electrical, and computer engineering in imaging processing, propulsion, and navigation. RoboSub is poised to give graduating seniors, as well other undergraduates, exposure to large project management constrained by real-world engineering problems and budget limitations.

RoboSub focuses on STEM fields while allowing incoming and future undergraduate students to develop and learn the innovative fields of control systems, power systems, navigation systems, autonomous design, and computer vision.

2. Project Objectives and Constraints

2.1 Problem Statement

RoboSub Team Killick is tasked to demonstrate an autonomous underwater vehicle (AUV) capable of following the requirements for the Navy RoboSub competition:

- Orange guide markers will help direct the vehicle to the beginning tasks.
- Two pingers will guide the AUV to the remaining two tasks
- The vehicle will have to scuttle a ship (touch buoys)
- Navigate a channel (pass over an obstacle)
- Weigh anchor (drop a marker)
- Set course (fire torpedoes)
- Bury a treasure (retrieve an object, surface, move/release the object).

2.2 Team Objectives

Each subteam has self-imposed objectives:

- Mechanical
  - Design and fabrication of physical bodies
  - Mechanical Failure Analysis
- <u>Sensor Team</u>
  - Image and inertial data collection and processing
  - Systems integration
- <u>Propulsion Team</u>
  - Power distribution
  - Propulsion mechanics and control

2.3 Design Constraints

The RoboSub team will adhere to all constraints provided by the RoboSub competition in addition to the subteams own, self-imposed constraints.

Mechanical

- Watertight fabrication
- 10% buoyancy per mass
- Modular design for maintenance
- Heat dissipation of a closed system

Sensor

- Processing speed (update rate of 5 Hz)
- Ease of programmability
- Modularity of code

Propulsion

- Power supply: 30 minutes of run time
- Low weight (six motors plus two batteries < 15lbs)

2.4 Final design Goals

Mechanical Design and Analysis

Have a fully assembled, watertight, and modular body that provides the ideal environment for the electrical systems.

Vision and Sensor Systems

To correctly identify a path using image processing and maintain proper orientation via inertial data.

Propulsion and Control Systems

Use calculated data to propel the vehicle in a safe and timely manner.

2.5 Estimated Budget

Item	***Cost***
Motors	$1800
Motor Control / MicroControl	$1000
Power Supply	$800
Sensors	$2500
MISC	$1000
Final Vehicle Chassis	$1500
Prototype Vehicle Chassis	$800
Mechanical Blunders	$1000
Electrical Blunders	$1300
Total	**$11,700**

2.6 RISK ANALYSIS

A tentative and incomplete failure mode and risk analysis (FMEA) is presented here for three primary systems: Mechanical Chassis, Battery Systems, and Sensor Systems. Significant systems to be developed for future revisions are master control systems, motor systems, motor driver systems, motor control systems, electrical compartment, and ballast systems.

Sensor Systems

Function	Functional Failures	Failure Modes	Failure Effects	Consequence Category	Mitigation
Provides data for navigation	Optical Failure	Optical Unit fails to transmit	Vehicle has collision	Damage to surrounding environment and vehicle chassis	Perform optical pre-check; surface on optical failure
		Optical Unit transmits unusable data	Vehicle has collision		Make sure camera is in stable operating temperature
	Audio Failure	Audio Unit fails to transmit	Audio navigation input/feedback data unreliable	Hydrophone Unusable, Vehicle must rely on other sensors	Ensure Hydrophone is operating properly before Vehicle submergence
		Audio Unit transmits unusable data	Audio navigation input/feedback data unreliable		Ensure Hydrophone is operating properly before Vehicle submergence
	IMU Failure	IMU Loses Positional Input	Vehicle loses positional navigation	Damage to surrounding environment and vehicle chassis	Perform IMU check; surface on IMU failure
		IMU Overheats	IMU navigation input/feedback data unreliable		Perform IMU check; surface on IMU failure

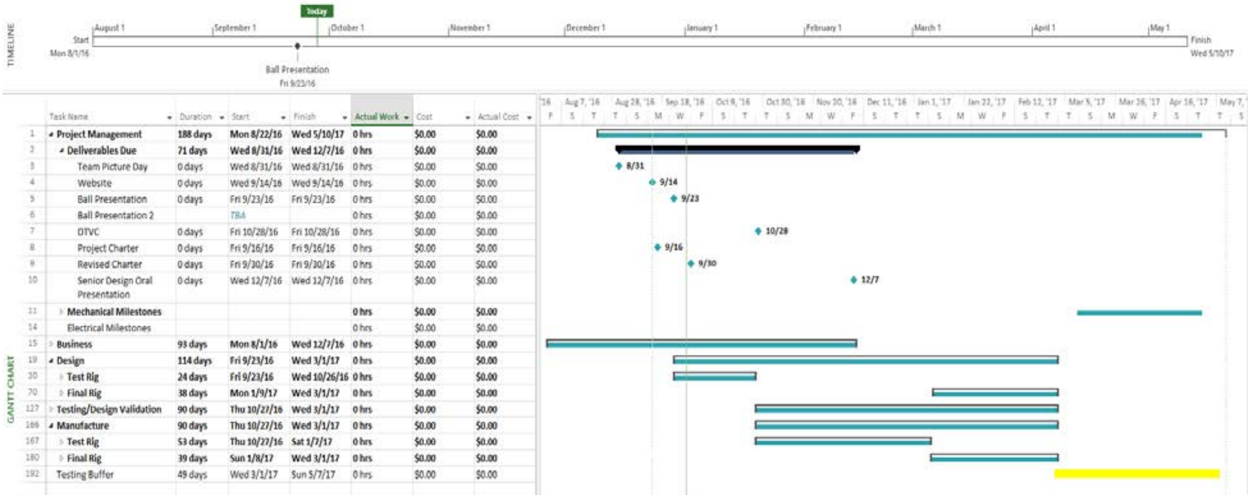
Battery

Function	Functional Failures	Failure Modes	Failure Effects	Consequence Category	Mitigation
Powers LV and HV systems	Overheating	Battery Explodes	Battery Destroyed	Components unusable, non-functioning vehicle	Mechanical isolation of battery; software controlled hardware relayed emergency surface
			Damages components	Components need repair, poor performance or non-functioning vehicle	Mechanical isolation of battery; software controlled hardware relayed emergency surface
		Burns hole in Electrical Compartment	Contaminants Water	Environment Contaminated	Electrical compartment designed to withstand water infiltration, isolation of battery from all other components/systems
			Water Damage to Components	Components non-functioning, vehicle unresponsive	Electrical compartment is designed to withstand water infiltration, isolation of battery from all other components
		Components miscalculate data	Vehicle fails to complete tasks	Poor performance or non-functioning vehicle	Implement temperature disconnect levels, mechanically cool vehicle
		Temperature Increase	Component/Systems Overheat	Poor performance or non-functioning vehicle	Implement temperature disconnect levels, mechanically cool vehicle

Electrical Housing					
Function	Functional Failures	Failure Modes	Failure Effects	Consequence Category	Mitigation
Protection of electrical	Water inside housing	Seals break/leak	Vehicle does not function	Non-Functional Vehicle, electrical components unusable, seals unusable	Perform tests without electrical components, choose design with least amount of sealing required, design with strongest and most rigid seals.
		Housing breaks/leaks	Vehicle does not function	Non-Functional Vehicle, electrical components unusable, housing unusable	Perform tests without electrical components, ANSYS stress analysis, materials research, choose reliable manufacturer for housing.
		Condensation	Vehicle does not function	Non-Functional Vehicle, electrical components unusable	Perform tests without electrical components inside, ANSYS thermal analysis, research condensation mitigation techniques.

3. TIMELINE

3.1 TIMELINE



	Task Name	Duration	Start	Finish	Actual Work	Cost	Actual Cost
1	**Project Management**	**188 days**	**Mon 8/22/16**	**Wed 5/10/17**	**0 hrs**	**$0.00**	**$0.00**
2	**Deliverables Due**	**71 days**	**Wed 8/31/16**	**Wed 12/7/16**	**0 hrs**	**$0.00**	**$0.00**
3	Team Picture Day	0 days	Wed 8/31/16	Wed 8/31/16	0 hrs	$0.00	$0.00
4	Website	0 days	Wed 9/14/16	Wed 9/14/16	0 hrs	$0.00	$0.00
5	Ball Presentation	0 days	Fri 9/23/16	Fri 9/23/16	0 hrs	$0.00	$0.00
6	Ball Presentation 2		TBA		0 hrs	$0.00	$0.00
7	DTVC	0 days	Fri 10/28/16	Fri 10/28/16	0 hrs	$0.00	$0.00
8	Project Charter	0 days	Fri 9/16/16	Fri 9/16/16	0 hrs	$0.00	$0.00
9	Revised Charter	0 days	Fri 9/30/16	Fri 9/30/16	0 hrs	$0.00	$0.00
10	Senior Design Oral Presentation	0 days	Wed 12/7/16	Wed 12/7/16	0 hrs	$0.00	$0.00
11	**Mechanical Milestones**				**0 hrs**	**$0.00**	**$0.00**
14	Electrical Milestones				0 hrs	$0.00	$0.00
15	**Business**	**93 days**	**Mon 8/1/16**	**Wed 12/7/16**	**0 hrs**	**$0.00**	**$0.00**
19	**Design**	**114 days**	**Fri 9/23/16**	**Wed 3/1/17**	**0 hrs**	**$0.00**	**$0.00**
30	**Test Rig**	**24 days**	**Fri 9/23/16**	**Wed 10/26/16**	**0 hrs**	**$0.00**	**$0.00**
70	**Final Rig**	**38 days**	**Mon 1/9/17**	**Wed 3/1/17**	**0 hrs**	**$0.00**	**$0.00**
127	**Testing/Design Validation**	**90 days**	**Thu 10/27/16**	**Wed 3/1/17**	**0 hrs**	**$0.00**	**$0.00**
166	**Manufacture**	**90 days**	**Thu 10/27/16**	**Wed 3/1/17**	**0 hrs**	**$0.00**	**$0.00**
167	**Test Rig**	**53 days**	**Thu 10/27/16**	**Sat 1/7/17**	**0 hrs**	**$0.00**	**$0.00**
180	**Final Rig**	**39 days**	**Sun 1/8/17**	**Wed 3/1/17**	**0 hrs**	**$0.00**	**$0.00**
192	Testing Buffer	49 days	Wed 3/1/17	Sun 5/7/17	0 hrs	$0.00	$0.00