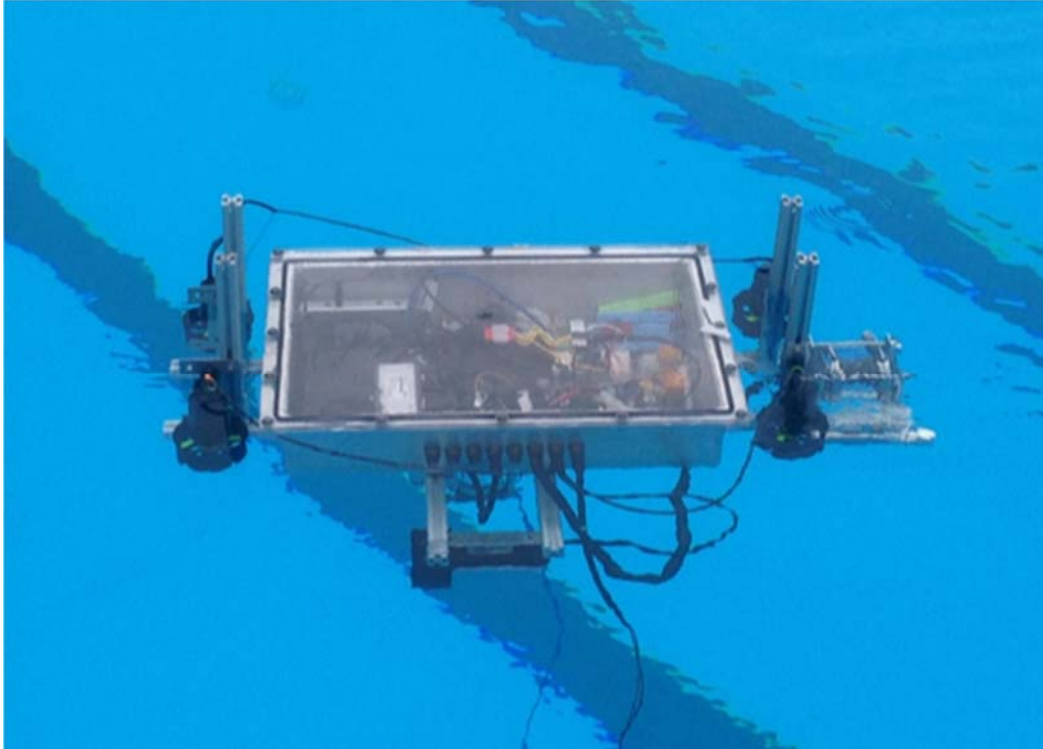


# Team 4: ECE RoboSub



Team Number: 04

Submission Date: 9/25/2015

Submitted To: Dr. Hooker

Authors: Brandon Anderson, LaNeicia Gomez, Travis Hett, Gabriel Mendoza,



## Table of Contents

### Contents

1	Introduction.....	5
2	Project Definition.....	7
2.1	Background research.....	7
2.2	Need Statement .....	7
2.3	Goal Statement & Objectives.....	8
2.4	Constraints.....	9
3	Conclusion .....	11
4	References.....	11

## Table of Figures

Figure 1. Course Layout.....6

## Table of Tables

Table 1. Competition Scoring.....10

## Abstract

This report contains the needs and other defining elements of the 2015 RoboSub senior design project. The goal of the team is to create an autonomous submarine meeting the requirements to compete in the AUVSI 2015 RoboSub competition. All the information in this report specifies what is needed in order to accomplish that. The project is a continuation of earlier senior design projects, which were still in development and incapable of meeting the competitions requirements. The needs of the submarine are to install the proper and utilize the proper devices for full functionality.

The steps already taken in pursuit of this goal are described in the sections below. The components of the sub have been briefly explored, and ideas are being conceived and shared that will improve the performance of the sub. After the ideas are discussed, more research will be conducted and designs will be planned out. From that, a course of action will be implemented on how to best complete the project.

# 1 Introduction

With a substantial increase in the use of autonomous systems, a growing need for developing this technology has led to the formation of many projects and competitions designed to spur research into this area. From research to military operations, autonomous systems can grant access to areas previously inaccessible to humans. Many competitions currently encourage people to develop autonomous systems of their own. One such competition is the AUSVI RoboSub competition. The objective of this project is to design an autonomous submarine capable of competing in the AUSVI RoboSub competition.

Currently, the RoboSub we have is not able to meet performance specifications set down by the rules of the competition. The sub must complete a number of tasks on a course as shown in Figure 1.<sup>1</sup> This paper aims to identify the needs of the RoboSub project in order to address them properly. Ultimately, the team hopes to make the current RoboSub able to compete in the competition next year.

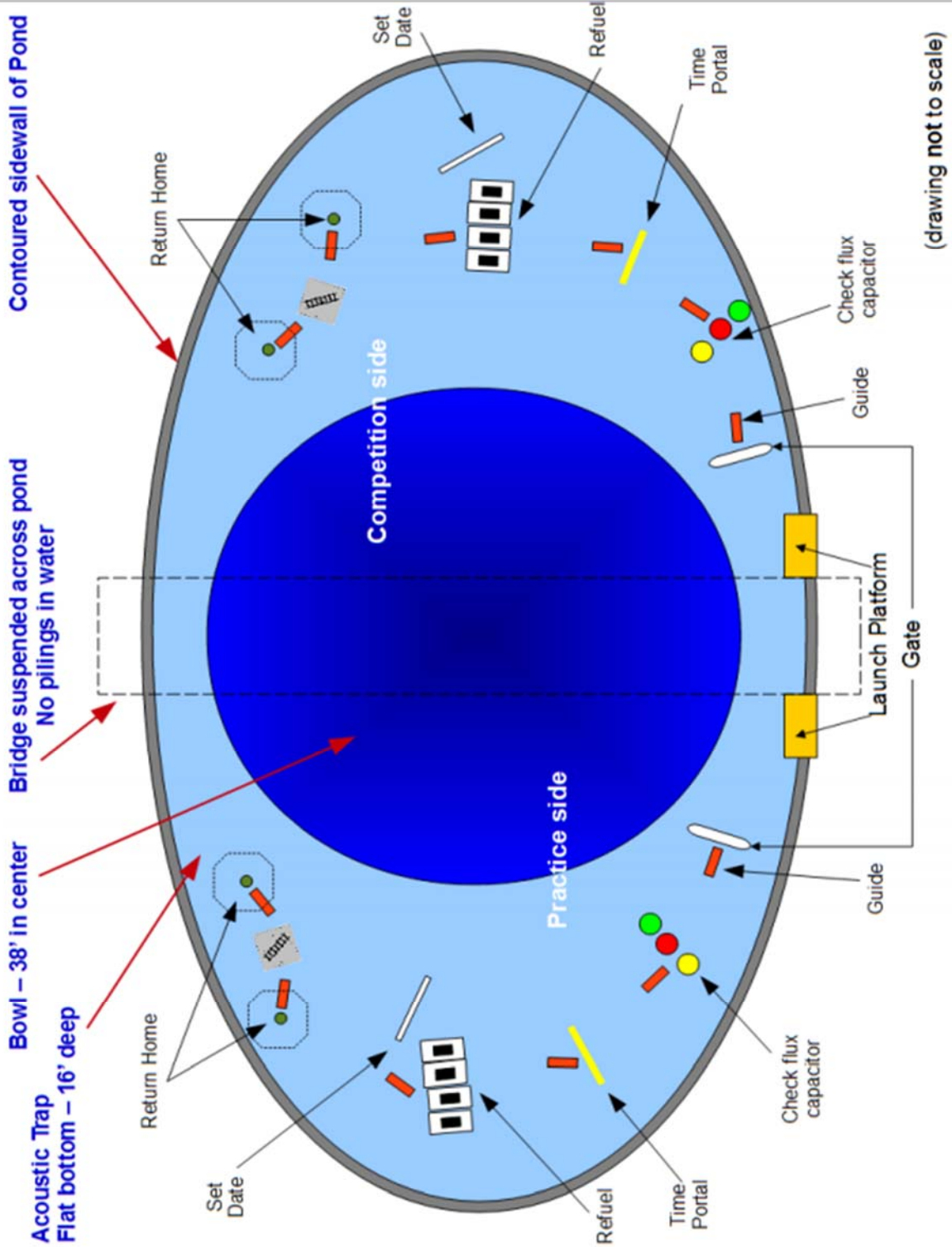


Figure 1. Course Layout

## 2 Project Definition

### 2.1 Background research

There have been many autonomous submarines built in recent years. The first robotic submarine used by the U.S. was the Autonomous Benthic Explorer developed in the mid 1990's.<sup>2</sup> The RoboSub used in this project is a continuation of multiple years of work by senior design groups, and is modeled after the same type of subs used by many other teams competing in the AUSVI RoboSub competition. In recent years, there have been many similar projects focused on developing autonomous submarines for various applications such as research, military operations, and exploration. Our sub differs from these projects in that it is focused on a specific set of tasks described by the rules of the AUSVI RoboSub competition, such as swimming through certain gates, maintaining depth and heading along a certain path, and firing torpedoes at markers. To help start the project off, there are many articles and other related literature describing autonomous subs and their design. One such article is "The NPS AUVII Autonomous Underwater Vehicle Testbed: Design and Experimental Verification" published by the American Society of Naval Engineers in 2009.<sup>3</sup> The previous Senior Design team also wrote a manual on the specifications and operation of the existing RoboSub.<sup>4</sup> This will be the main source of information used in developing this year's project.

### 2.2 Need Statement

The project is required because it provides an opportunity for students to implement the knowledge gained from the many courses taken during the student's undergraduate career. The College of Engineering will allow this project to be done by sponsoring this group. Not only will this project be an investment financially, it will also serve as a mental investment. The faculty is determined to ensure that the students are successful. By doing so, the College of Engineering have provided information and a RoboSub from previous years. The current situation for the project is that it needs improvement before taking it to competition. The RoboSub is



unsatisfactory because there are cracks in the glass that protects the internal parts from water damage. The size and shape of the current RoboSub is also unsatisfactory. Because of the many components, there is a large power consumption. This will require a battery that will have a long enough battery life to sustain the sub for the course it will have to run. The Robo Sub is not properly balanced when maneuvering underwater due to it being extremely buoyant. Both the internal and external parts of the RoboSub need to be analyzed and reconsidered before taking it to competition.

Need Statement: The current RoboSub has too many complications that prevent it from being competition ready.

## 2.3 Goal Statement & Objectives

Continue developing an autonomous submarine that will meet the requirements of the AUVSI foundation's RoboSub Competition.

### **Objectives (based on 2015 competition requirements<sup>1</sup>):**

- Identify gates floating near the top of the water and steer through them
- Identify guides on the bottom of the pool and reorient the sub to follow them
- Identify multiple colored buoys and touch them in a specified order
- Identify a floating "portal" and navigate through it
- Identify bins on the bottom of the pool, one with a lid to be removed, remove the lid and drop markers into it.
- Slide open a door revealing multiple holes and corresponding numbers, then fire torpedos through specific holes to signify a certain number
- Identify and move two objects from location to another in a specific order
- Surface the sub up into a certain area

## 2.4 Constraints

- The RoboSub must comply with all of the AUVSI foundation's competition rules:
  - Sub must be less than or 125 lbs
    - o Sub must be less than or 84 lbs for no penalty to be incurred.
  - Sub must be maneuverable through "gates"
  - The torpedoes size, weight, markings and potential "loss" are identical to the Markers.
    - o The torpedoes must travel at a "safe" speed.

A "safe" speed is one that would not cause a bruise when it strikes a person
  - Each marker must fit within a box 2.0" square and 6" long.
    - o Each must weigh no more than 2.0 lbs in air.
    - o Each marker must bear the team name or an emblem.
    - o Penalties are as follows:

Any marker that exceeds these limits by less than 10% will result in a 500-point penalty. Any marker that exceeds these limits by more than 10% will be disqualified.
- The total cost must not exceed the allotted budget
- An example of competition constraints is listed in Table 1.<sup>1</sup>

Table 1. Competition Scoring

<b>Subjective Measures</b>	<b>Maximum points</b>
Utility of team website	50
Technical merit (from journal paper)	50
Written style (from journal paper)	50
Technical accomplishments (from static judging)	75
Craftsmanship (from static judging)	75
Team uniform (from static judging)	10
Team Video	50
Discretionary static points (awarded after static judging)	40
<b>Total</b>	<b>400</b>
<b>Performance Measures</b>	<b>Maximum points</b>
Weight	See Table 1
Marker/Torpedo exceeding weight or dimensional specifications by < 10%	-500 per marker
Pass through the validation gate	100
Maintain a fixed heading through gate	150
Follow the "Path"	100 /segment
Check Flux Cap (any solid, Red than Green)	400, 800
Time Portal (>½ above, <½ below & parallel)	400, 600 // 1000, 1400
Straight through // with Style	
Refuel: remove lid	700
Refuel: any, primary/secondary	500, 1200 / marker
Set Date: remove lid	700
Set Date: any, corr lg, corr sm	500,1000,1500 / torpedo
Surface within an Octagon	500
Surface within the correct Octagon	2000
Surface with the Object	600 / object
Drop the Object	200 / object
Object on Railroad	1000 / object
DeLorean in front of Train on Railroad Track	1000
Finish the mission with T minutes (whole + fractional)	T x 100

### 3 Conclusion

Through the course of this project, the team hopes to improve the functionality of the current RoboSub to make it ready for competition next year. The major need of this project is that the RoboSub is currently unfit for competition. Although there are many challenges to be met, and many of the requirements of the competition have not yet been met, the team feels confident in its ability to create a competition ready sub. Moving forward, the team will evaluate the order of importance that different things need to be done, and develop a schedule for the completion of different parts of the project. Work on developing the different systems of the sub has already begun, and will be aided by the collaboration of the ME RoboSub team with ours.

### 4 References

- 1) AUVSI Foundation 2015 RoboSub Competition Rules and Mission <http://higherlogicdownload.s3.amazonaws.com/AUVSI/fb9a8da0-2ac8-42d1-a11e-d58c1e158347/UploadedFiles/RoboSub%20Competition%20Official%20Rules%20and%20Mission%20-%202015.pdf>
- 2) Woods Hole Oceanographic Institution. <https://www.whoi.edu/main/ABE>
- 3) Wiley Online Library. <http://onlinelibrary.wiley.com/doi/10.1111/j.1559-3584.1992.tb02238.x/abstract>
- 4) FSU RoboSub User Manual. [http://fsurobosub2015.weebly.com/uploads/1/0/3/7/10377608/user\\_manual.pdf](http://fsurobosub2015.weebly.com/uploads/1/0/3/7/10377608/user_manual.pdf)