



красный октябрь (Red October)

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Tennessee Tech University offers a Senior Design Project course which provides students with a capstone experience in the use of mechanical engineering design for the solution of engineering problems. Students work in a team format on selected mechanical engineering projects emphasizing both mechanical systems and thermal science design aspects.

Introduction

After reviewing many different possibilities for a senior design project, one of the groups decided to move toward aquatic exploration. More specifically, to design a submersible vessel with the ability to dive, surface, and navigate underwater by remote control.

Background

Why build such a device? Since the 9-11 attacks, the U.S. government has a much more stringent security program to fight its war against terrorism. One of part of the security program is the Anti-Terror Squad. The main duties of the squad is to look for explosives and drugs attached to ships' hulls and making sure there are no bombs on the seawalls where the Navy ships dock .

Objective

Even though the squad is fully trained there are a few disadvantages they face as they perform their job. These disadvantages range from working in near-zero visibility conditions, to the lack of maneuverability in tight areas. Building a submersible vessel will help the squad in the following ways:

- Better visibility conditions via LED lighting system
- Searching confined areas inaccessible to divers
- Keeping divers out of the path of moving vessels

Conclusion

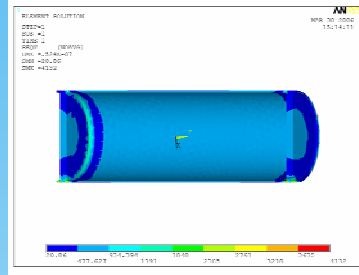
- Exciting, challenging, and intriguing multidisciplinary design project
- Meets the course criterion
- Robust design can be easily adapted for future tasks

Design Analysis

The group had to analyze numerous aspects of the submarine. These analyses were conducted through both analytical and experimental methods to ensure the submarine would function properly. Analytical methods include:

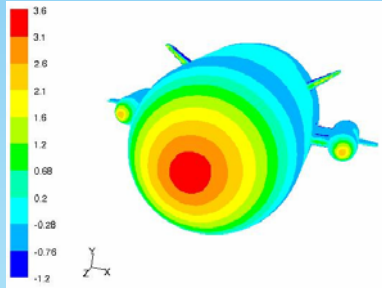
FINITE ELEMENT ANALYSIS

A stress analysis was provided by Ansys to see how the ballast tank would react to the CO₂ pressure. (Stress Scale - PSI)



FLUENT ANALYSIS

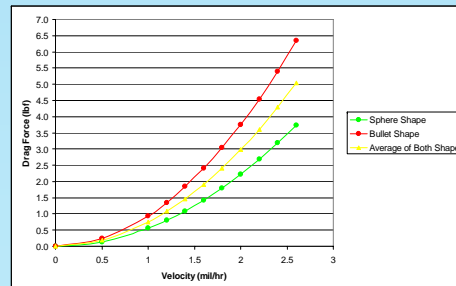
Fluent was utilized to figure out the total pressure distribution through the submarine. (Total Pressure Scale – Pascal)



DRAG FORCE VS. SPEED

An analytical approach was used to provide an approximation of the drag forces the submarine would need to overcome.

$$D = \frac{1}{2} \rho V^2 A C_d$$



Approach

The many rounded contours and fins made conventional fabrication difficult. Tennessee Tech's rapid prototyping machine, however, made short work of the hull, propellers and extrusions.



Motor Mounts

