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2.00AJ / 16.00AJ Exploring Sea, Space, & Earth: Fundamentals of Engineering Design
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Designing Nemo



Team BuMz

2.00A/16.00A Final Project 2009



Design Process:

Our basic design concept was centered on simplicity. As a result we chose a simple frame shape, a 9"x 9" cube sitting on an edge as shown in Figure 1. Two 500 gpm motors are mounted at the rear and one 750 gpm motor is mounted at the top. The mounts for the motors are shown in Figures 2 and 3. The camera and LED lights are mounted at the front. There are two buoyancy canisters at the top to keep it upright, one of which houses the instrumentation. Weight is distributed so that the center of mass is at the center of the cube.

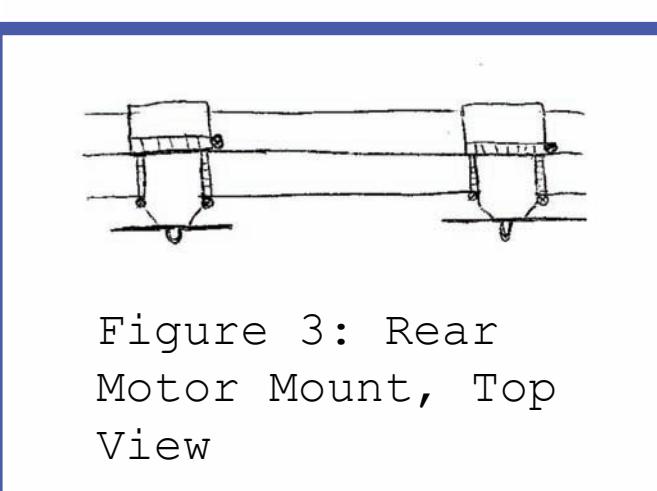
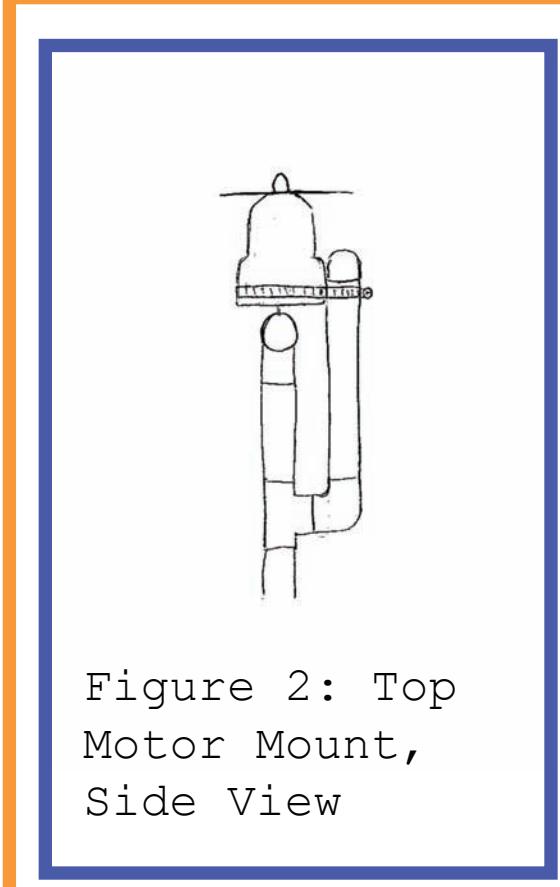


Figure 2: Top Motor Mount, Side View

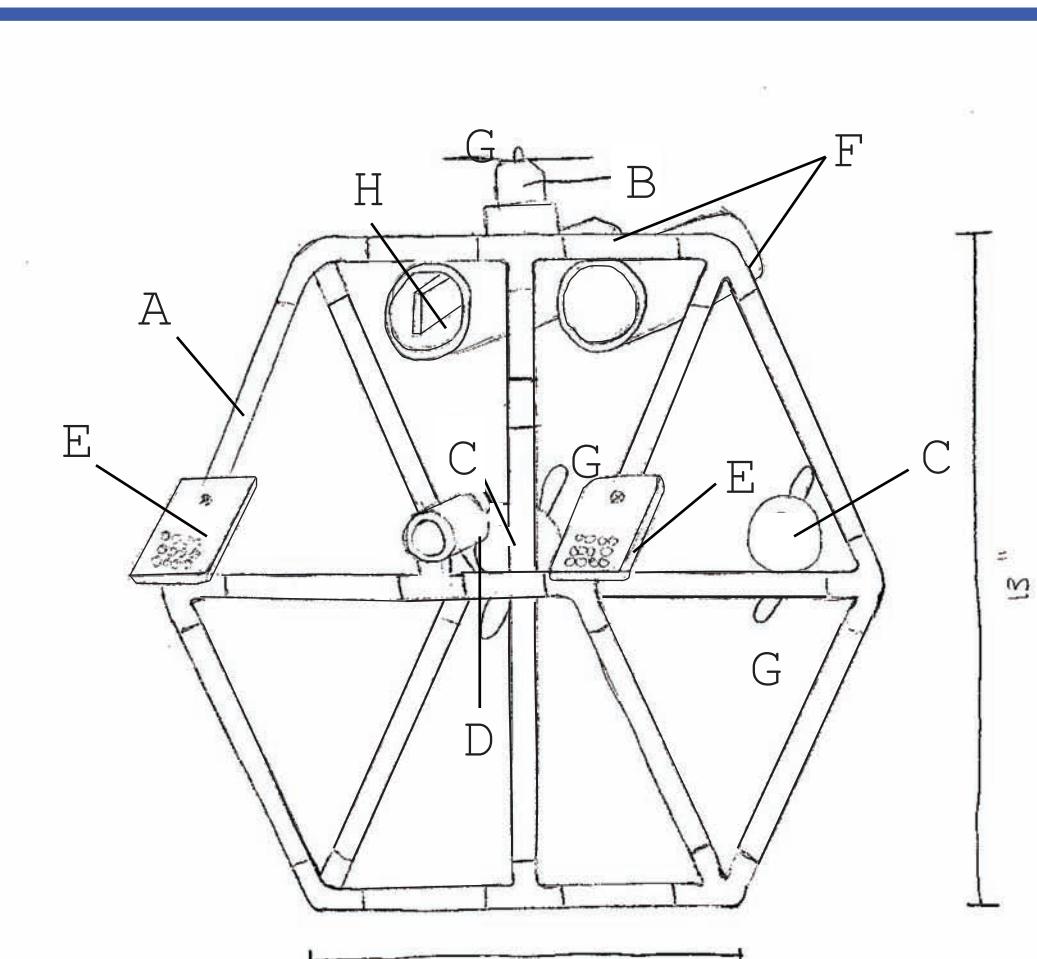


Figure 1: Nemo Basic Design

Parts List:

- A- 1/2" PVC Pipe/ connectors
- B- 1X 750 GPH motor
- C- 2X 500 GPH motor
- D- Camera
- E- LED light bank
- F- PVC Buoyancy Canisters
- G- Propellers
- H- Instrumentation

Performance:

Pool testing was very helpful for us. The first time we tested, the rear motors worked but the top did not and we ended up blowing a fuse because of some faulty wiring. The next pool test went much more smoothly. Nemo worked very well and with minimal malfunctions. The only issues were with the instrumentation container and the propellers. Water-proofing the instruments with plumber's putty was not working so we switched to monkey dung. Also, due to the waterproof endcap the buoyancy was thrown slightly off, causing Nemo to veer slightly to one side. This is easily compensated for by the driver of the ROV. The plane propellers we used kept falling off so we had to superglue them on. Testing in the river went very smoothly. The only minor issue was slight leaking into the sensor package, however it did not hurt the sensor. The only thing that didn't work well was the camera because of the murky water.



Pros and Cons:

Pros:

- Simplicity
- Ease of Build/ Repair
- No need to waterproof frame

Cons:

- Difficult to mount motors and other components

Results:

We recorded data both times we launched Nemo into the Charles. However, upon inspection the data columns in the file do not seem to match up with what they are supposed to be. We think there may be a problem with our sensor. Our observations were that Nemo made it to a depth of approximately 20 feet and that there was very little light.

Design Analysis:

There are a few issues with the motors. The rear motors are heavier than expected so we added a little bit of buoyancy to counteract this. Another issue is that the mounts are a little unstable. As shown in Figure 4, the top motor provides vertical thrust and the rear motors provide horizontal thrust and allow Nemo to turn. Due to the issues with the stability of the motor mounts, to ensure that the forces are applied where they are meant to be applied the orientation of the motors must be checked before Nemo is submerged. Nemo's propellers are 4 inch black airplane propellers which produced around 1.3 pounds of force when tested in lab. These propellers were chosen because they work best when close to the vehicle as opposed to the boat propellers which work best when extended out from the motor. We calculated the size of the buoyancy canisters to be such that when the frame is full of water, it will be neutrally buoyant.

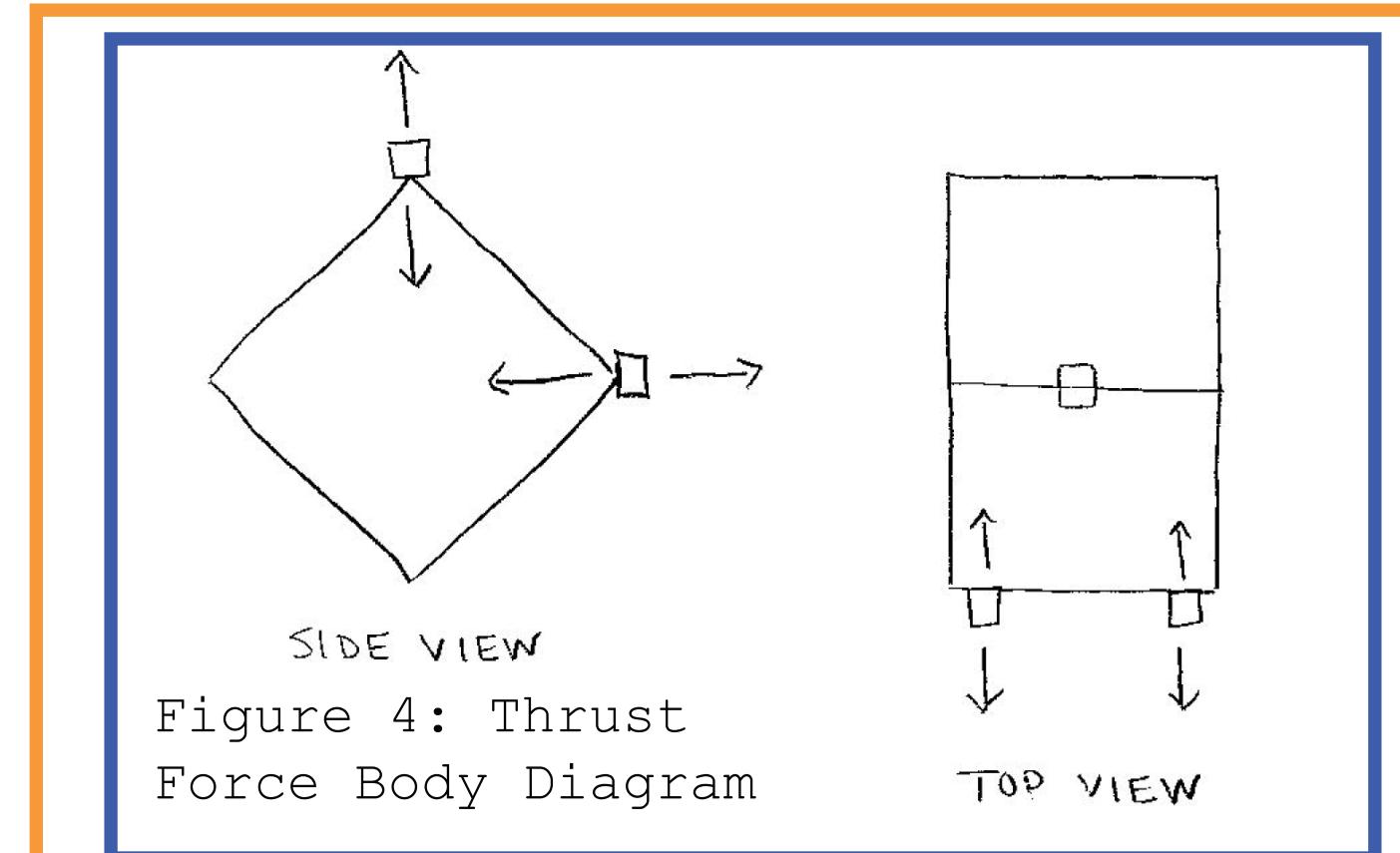


Figure 4: Thrust Force Body Diagram

Reflections:

We unanimously agree that this was the coolest thing we have ever done. If we were going to do it again, with the added wisdom and maybe a little more time, we would probably try a more ambitious design. We kept our plans purposely simple so as to maximize the probability of the ROV actually working when we dumped it into the Charles, but it would be great to try something a little more complex. All in all we learned a ton and had a great time! And we made the cutest ROV ever!

