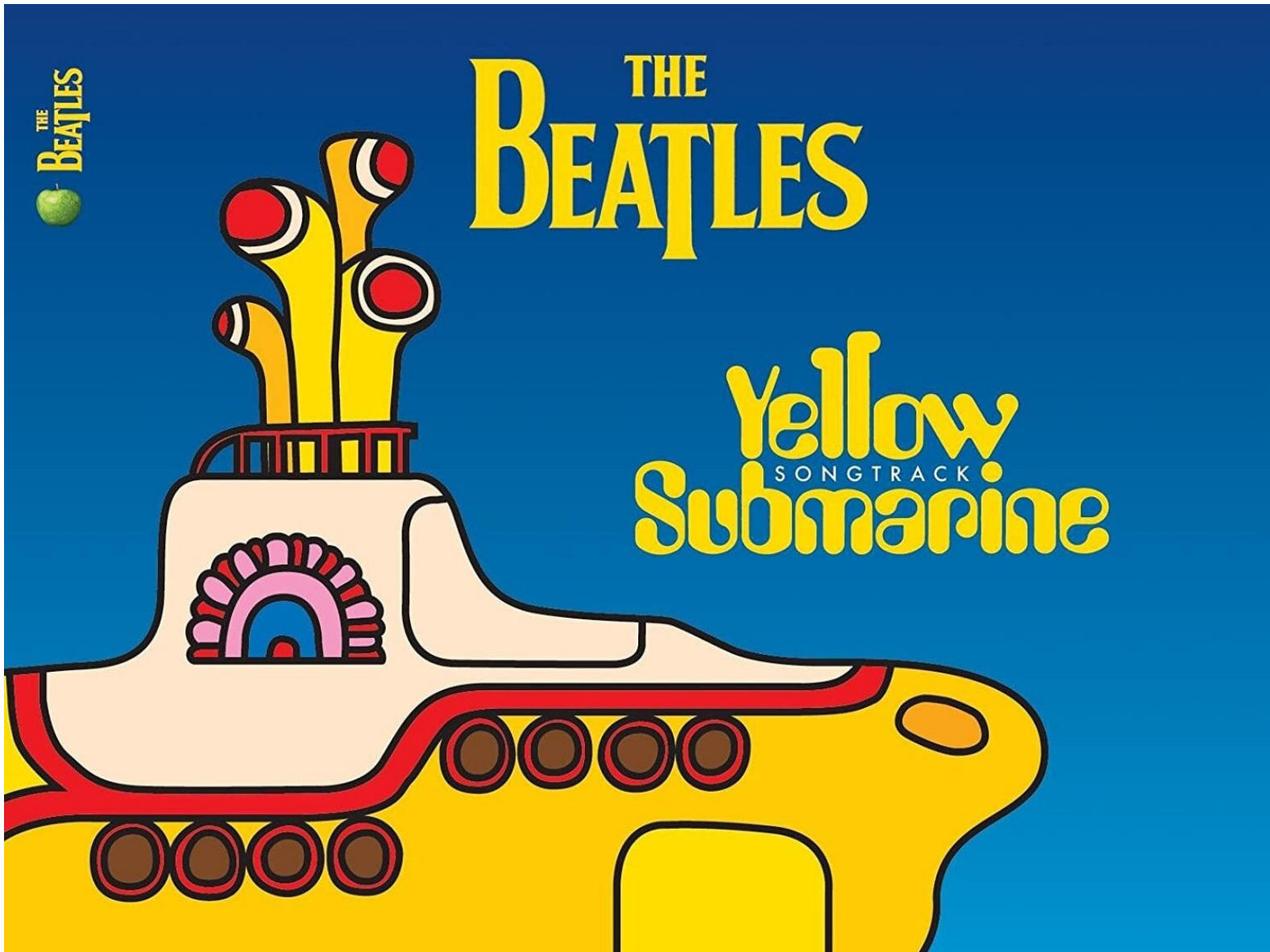# Mini-Sub: Introduction

Learn how to model in CAD by creating a mini submarine you can keep!

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Introduction

Getting into CAD can be daunting. Like code, it can feel like learning a whole new language - or art, in this case. Well, fear not, Robotics @ Maryland is here to help! By taking this course, you'll get valuable experience in 3D printing, modeling, and understanding submarine buoyancy in an open-ended project. You'll even get to keep what you make!

The mini-sub is a required project for freshmen and sophomore students, or those without significant CAD experience. By the time you're a junior, most of you will have taken Intro to CAD. This is supposed to be a smaller version of that!

Even though this is fairly open-ended, we do have some requirements to make sure you're learning.

Requirements for completion:

1. Completely enclose and fit a water balloon and small tube in the back.
2. The largest your sub can be is 6"Lx3"Wx4"H. Your enclosure needs to be around 6x3x3 to properly fit the balloon, with an extra inch at the top of extra design.
3. Needs to look like a submarine (no boxes!).
4. Your submarine must also have a Sail and small windows.

The rest is up to you. Good Luck!

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Step 1 — What Even Is A Submarine?
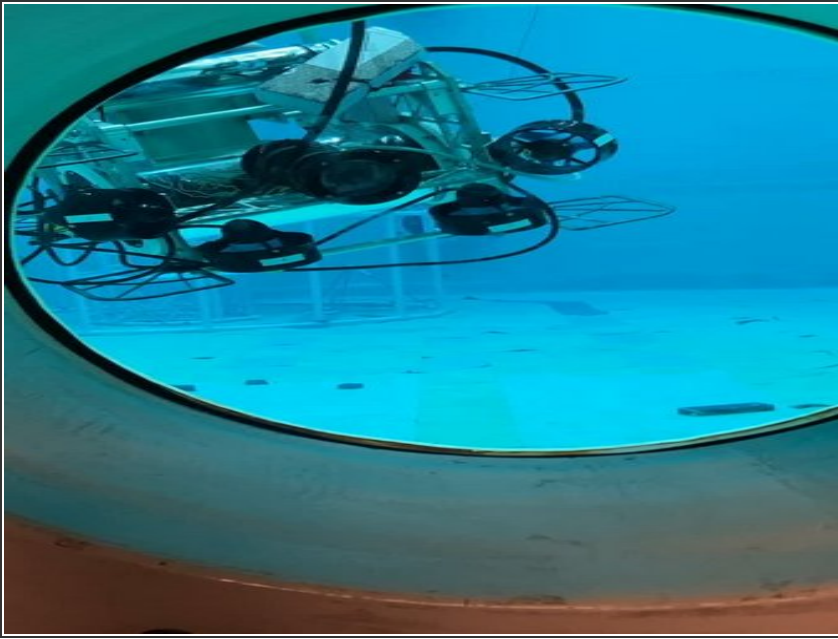
- In essence, a submarine is a tank of air that is designed to both keep you alive and move underwater, among other things.

- What we're focused on is how they move up and down. Unfortunately we don't have thrusters for our subs. But we can use science to help it dive and surface.

Step 2 — Buoyancy
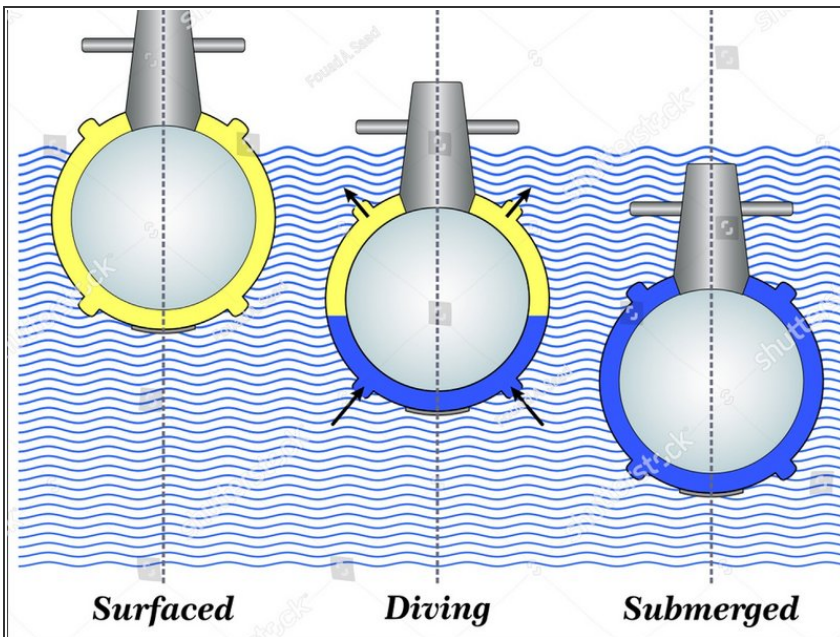
- A submarine is a controlled open system. This means outside mass can enter and leave. The submarine uses this to its advantage by controlling its weight.

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- A submarine has a fine tuned weight so it floats on its own. Then as it wants to sink, its tanks (called "ballasts") fill with water. Water has now entered the system - and when

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the weight of the system is more than the water it displaces, then it sinks!

- Ships and submarines can float because their mass is less than the water they displace. It's the same reason oil floats on the surface of water!

- Here's how ships float: if you take the volume of the submerged part of the ship and multiply by the density of water, that's how much the ship weighs.

Step 3 — Making Your Sub Dive

- Our sub works in a similar way! When the balloon inflates, you're displacing a lot of water with air which is really light, causing it to float.

- When the balloon deflates, much less water is displaced, causing it to sink.

- We do this using a syringe that you can control from outside the water. This is connected to a balloon so you can control how much air's in the system.

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Step 4 — The Process
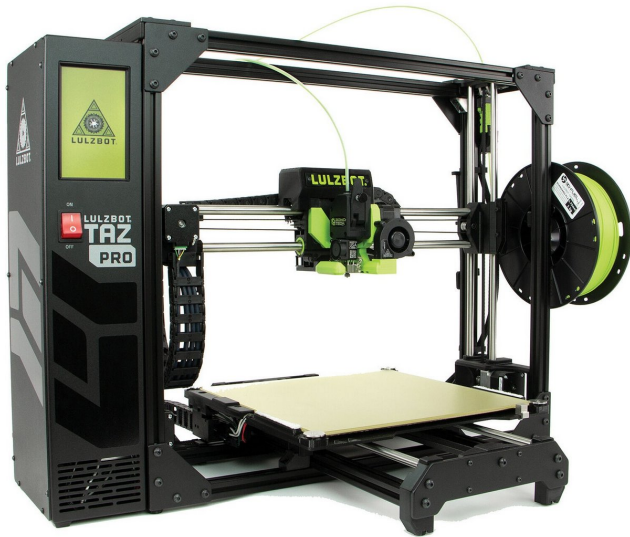
- To make your own, you'll be learning how to 3D print on our printer! Review the 3D printing trainings for the necessary software and running a print.

- This guide will be focused on making the actual model. We'll be doing this in SOLIDWORKS, our main modelling software. Be sure to download this through terpware.umd.edu!

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