# Blueprint for first Nautono Sail

The following is a back of the napkin blueprint for the first sail. This is to serve as a point to iterate from. This document should also be modified with your own thoughts.

## Research

You need to understand and read up on the following:

1. [How boat stability works](https://en.wikipedia.org/wiki/Ship_stability)
   1. [Primer on basic properties of boat stability](https://www.marineinsight.com/naval-architecture/ship-stability-introduction-hydrostatics-stability-surface-ships/)
   2. Testing
      1. How to simulate buoyancy (most important test properties to determine are your ‘natural waterline’ and your ‘GZ curves’)
      2. Get familiar with FloatSoft software
      3. Keep your mass budget updated, and ensure all parts have a mass in SolidWorks
2. Basic wing aerodynamics:
   1. How lift works
   2. The lift equation
   3. How does a flap control a freely rotating wing?
   4. How to select wing profile shapes (hint: based on expected Reynolds #)
   5. How to model wing profiles
3. How did other teams design their sail?
4. Learn how to use multibody modelling in SolidWorks (creating multiple bodies in one part file)

## Main Components of Sail

1. Wing
2. Flap
   1. Flap control (such as a linear actuator)
3. Mast
4. Counterweight

## Designing the First Wing

The size of the wing is determined by how much sail area can the boat handle without compromising it’s ability to self-right (which is tested using the ‘GZ curves’ simulation).

You should start the sail design by guessing a bunch of values (size and mass of the sail), and testing how the sail affects ship stability (using floatsoft). Your first design will probably cause the boat to sink (too heavy) or tip (center of gravity too high). Iterate the size and mass until the boat is able to confidently self-right.

Remember that wind will also create a tipping moment (by pressing on the sail and rotating the boat on along it’s center of gravity). Ignore this initially for simplicity.

### Designing the first wing

1. Select your wing profile
   1. Such as NACA0015
   2. You can base this on the expected Reynold’s numbers. NACA15 is what I found to be necessary for our expected windspeeds and general sail size.
2. Aim for a minimum of 3:1 ratio for span to chord (wing is three times taller than it’s width)
   1. For your first chord length, guess a reasonable value based on the size of the boat (say 0.4m)
3. Select a maximum mass for the wing (this is just to limit the span of the wing)
   1. Guess a reasonable value (say 8 kg)
4. Model the wing as foam core
   1. Use density based on foam commonly used for wings, or full send and use house insulation
5. Estimate density of carbon fiber/fiberglass + epoxy required to wrap foam core
   1. Can base it off of surface area of wing
6. Insert mass properties into model

Aim for 8kg (mass of the wing and mast combined), this is literally just something to get you started.

* 1. Model the wing as foam core. Get a density value
  2. Determine mass of carbon fiber (or fiberglass) + epoxy mixture required to cover foam core. You can estimate based on surface area of wing, or some sort of density value you’ve come up with.
  3. Iterate the span height until the foam+carbon fiber mass reaches your target mass (ex. 8kg)
     1. MODEL AS SINGLE PART (MULTIBODY PART), DO NOT MODEL AS ASSEMBLY
     2. Can also use surface area as method of determining mass of carbon fiber/epoxy mixture
  4. Modeling using MULTIBODY PARTS instead of assemblies is your friend here. Learn multibody modeling in solid works (meaning creating multiple parts in one part file).

**How do we design the flap shape:**

1. To start, straight NACA15 profile or thinner, use supporting literature.
2. Aim for minimum 3:1 ratio of span to chord
3. Aim for 2kg
4. Distance between flap and wing defined by size of linear actuator

**How do we transfer power to sail:**

Use the slip ring option:

1. Slip ring
   1. Electrical team has to source a slip ring that can handle moisture exposure
      1. Examples (not rated for moisture, just as a basis to start looking)
         1. <https://www.adafruit.com/product/736>
         2. https://www.aliexpress.com/w/wholesale-electrical-slip-rings.html
2. Independent battery pack with radio controller embedded in wing
   1. Pack of 18650 batteries with AliExpress BMS.

**How do we measure rotation:**

Magnetic encoder (no potentiometer!)

* Magnetic encoder chip
  + <https://www.aliexpress.com/i/4001097880511.html>
* DIY ring of hall effect sensors