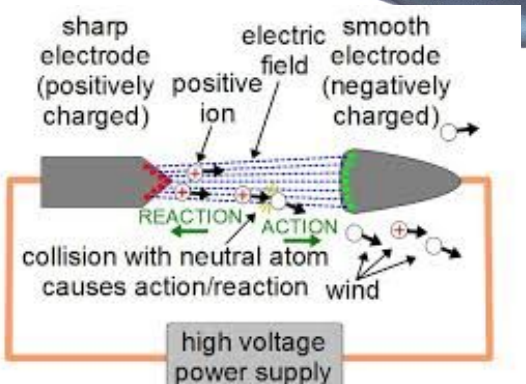
Ion Propelled Airship

Created by Aidan Witters



Disclaimer (sort of)

Because the “STEM demonstration” (I think of it as quarantine-innovation-expo) is non-competitive this year, I have stuck to the Rubric less strictly. Deal with it.

The ~~Problem~~ Question:

How can cargo be transported at high speeds without burning fossil fuels?

My solution (short explanation): Ion Propulsion; a type of engine that uses 0 moving parts and runs on electricity alone.

Background Research on Ion Propulsion

1. Ion Engines are notoriously weak (-literally every source I've found), so it can't effectively lift a heavier-than-air-aircraft, as proven by the WEAV (Wingless Electromagnetic Air Vehicle) developed at the University of Florida, which only suspended itself a few millimeters off the floor for a few minutes. -Wikipedia
2. "Ion Lifters" are small aluminum-foil-and-wire constructions which demonstrate ion propulsion (in an atmosphere), and are very easy to construct, therefore perfect for this project.
3. The equation for thrust from an ion motor is:

$$F = \frac{Id}{k}$$

   - *F* is the resulting force.
   - *I* is the electric current flow.
   - *d* is the air gap.
   - *k* is the ion mobility coefficient of the working fluid, measured in amp-sec^2/kg in SI units. (The nominal value for air is 2×10^{-4} m^2 V^{-1} s^{-1}). -Wikipedia
4. Lighter-than-air crafts can and have been propelled by Ion engines -A german company called "Festo"

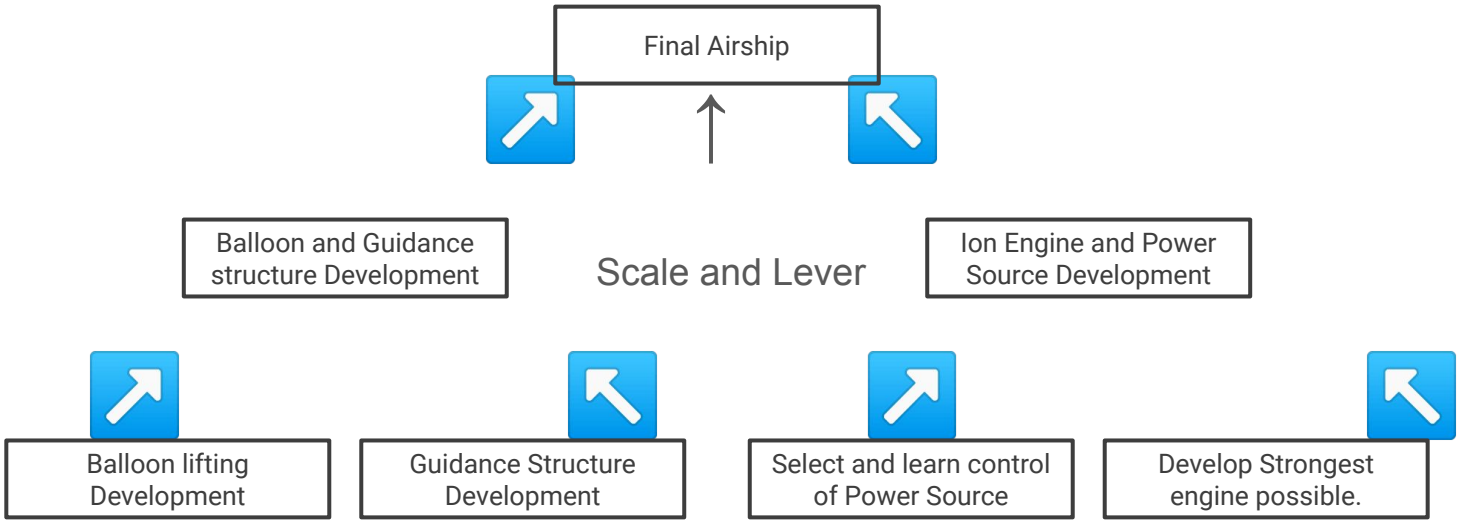
The Solutions:

1. An Ion Propelled airship to carry cargo, that is (ideally) solar powered. Obviously I can't actually build one, so more like: a couple balloons suspending a triangle of tinfoil and some wire.
2. An electric (and ideally solar powered) airplane to carry cargo, (this idea is unoriginal though, I've seen at least 3 other projects like it.)
3. Just use an electric boat. (that's lame, so I won't use this one.)

Planning, Creating, and Improving.

This is where things started getting complicated. From this point on, the rubric is ineffective for organization.

How Development Went:



This project has too many subsystems to actually follow the rubric properly, this is the result, although this diagram still isn't entirely accurate either.

Balloon Lifting Development

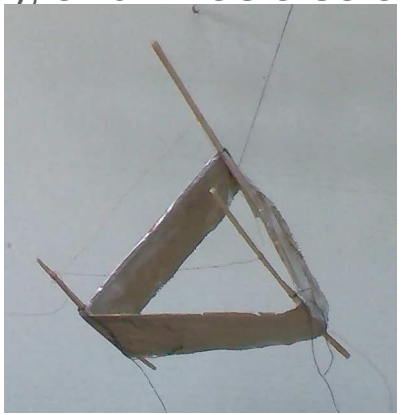
This was probably the simplest step of the process, all I did was attach a 9 inch balloon to a kitchen scale with some thread, and checked the weight: each 9 inch balloon full of 80% helium can lift 2 grams. This number came in handy later.

Select and Learn Power source:

Selecting wasn’t too difficult,as there was only one high-voltage power source in the house, however, it took 3 or 4 shocks (about as bad as a static shock from walking on a carpet) and 4 or 5 GFI (ground fault interrupter) trips before I knew how to use the power source properly without shocking myself or cutting power to the entire kitchen.

Develop Ion Engine

I started with a base Ion engine design I found online, a triangle of tinfoil supported by 3 lightweight sticks, and a thin wire attached to those sticks. This design (unfortunately) wasn't able to take off, because the only aluminum foil in the house was too heavy, and the power source was relatively weak. At this stage I was, however, able to test whether it was producing thrust by putting a piece of tissue paper under it and watching if it moved (it did), and I was also able to test if reversing the polarity changed anything (it did not).



Develop Guidance Structure

The first guidance structure was a few threads to stabilize the Ion engine while it went straight up, it didn’t have enough thrust to go up however, so the next structure was a kind of pendulum that the engine would hang from, I would then measure the angle it moved to when turned on, and from that number and the weight of the engine calculate the thrust.

Balloon and Guidance Structure Development

At one point, I had thought I'd be able to avoid getting actual helium, by simply hanging the engine from a string, and letting it move sort of like a zipline, however it quickly became apparent that even with the slipperiest string I had (fishing line) it would be too much friction, so I eventually decided I'd have to use helium. As for the structure itself, I knew that the string would have to be taut, so the first structure had a system where the string was suspended between 2 tripods, one of which had a shorter leg, which allowed it to lean back, and make the string taut. However, this structure was constantly falling over, so another was developed, it was smaller and used 2 parallel strings to keep the airship pointed forwards,this one was kept taut just by the friction of the stands on the ground, as the airship I had constructed at that point had achieved approximate neutral buoyancy, therefore negating the need to have super taut strings.

Ion Engine and Power Source Development

At this stage, I finally had developed everything far enough to measure results by using this system: all of the numbers can be found here, as I could not make them fit on a google slide, the short version is this: I tested different distances between the wire and the tinfoil until I found the most thrust; 25 degrees, 1.3 mph wind, at a distance of 1 ¼ inch.

The ability to weigh things

The kitchen scale I used couldn't actually measure the weight of the Ion engine, as it was much too light (1.5 grams). So, in order to weigh it, I grabbed some legos, and built a lever, and did some calculations (ratios found here). This allowed me to find weights as small as 0.3 grams (approx).

Final Ionic “Airship”

“Balloon Motor” may be a more accurate name, but “Airship” sounds cooler. The Final Airship has the optimum tinfoil-wire distance, the correct amount of balloons or neutral buoyancy, and two parallel low-friction fishing lines suspended taught for guidance, due to time constraints (and having to take everything down before further refinement so that the kitchen is usable) I wasn’t able to effectively measure speed thrust etc, but at least it worked,and here’s some unedited footage, and a photo gallery ‘cause why not.