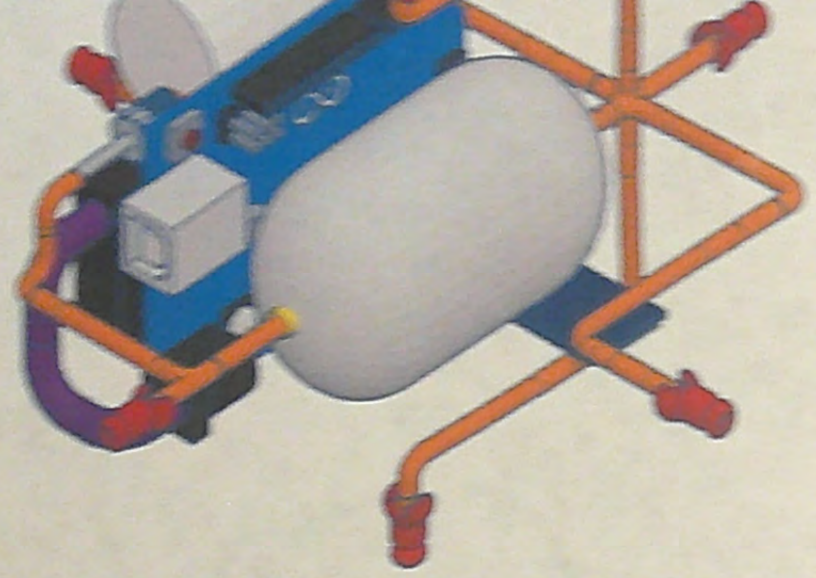
Note to Semi-Finalists

Thank you very much for participating in the HUNCH Design and Prototyping. This was by far the most difficult year for deciding finalists. Part of the difficulty was the number of teams participating but the most important part was the number of high quality of prototypes for each of the 10 projects.

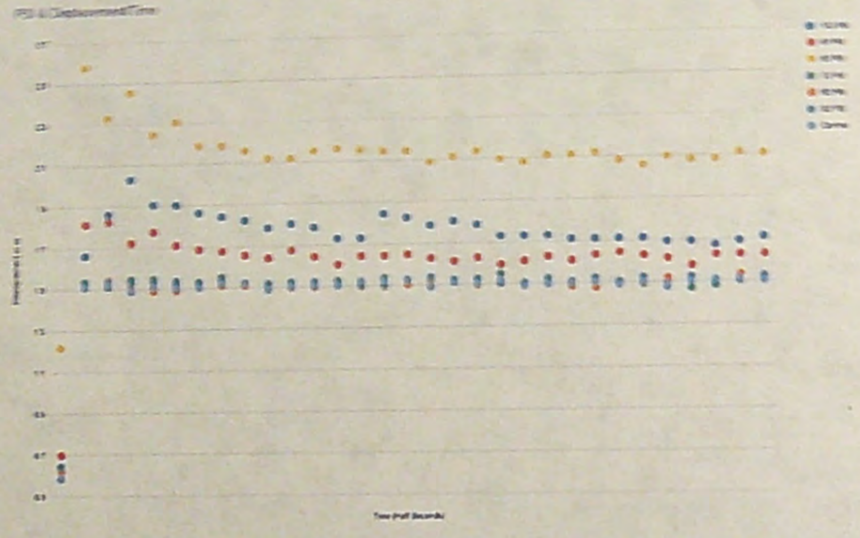
Each Mentor helped choose potential finalists for their area and were then compared with the same type of projects across the country. Teams that were selected to be finalists had very tough competition and it was very difficult to down select. Although everyone wants to be a finalist it isn't possible and decisions have to be made. Some of the decisions include the requirements but also trying to show diversity of how the problem could be solved. There was no shortage of good and diverse ideas.

Being a Semi-Finalist is a great honor because each of you put together a project and data that made the teams think, learn and be excited about space. Your great ideas and hard work is what makes NASA HUNCH a challenge and a great experience for engineering. We hope you enjoyed the projects as much as we all enjoyed seeing your prototypes.

If you are a senior and moving on to college, industry, or trade schools, make sure you include your project with NASA HUNCH on your resume. You will find that your interview will center on "what did you do for NASA?" The more you tell them, the more they will want to hear. You will be receiving a letter of recommendation from NASA HUNCH describing Design and Prototype and the project you worked on. We hope that your work will translate to opening doors for your future. Thank you for being in the NASA HUNCH Design and Prototype Program.



Data



Testing & Results

Testing was done on a single axis pendulum that uses a metal pipe balancing between 2 ball bearings to determine the amount of thrust produced.

The results showed a small force (approximately 5 kN) pushing the entire body.

Create a propulsion system that works in a zero-gravity environment.

Similar to the directional water jet system that octopi use.

Videos

Video

Testing solenoids using gyroscope input.

Video

Testing the air tank with the solenoids and the new fittings.

Video

Testing piping system with compressed air (100 PSI).

In order to prevent major impacts if the robot bumps into an object a soft-shell will encompass the robot.

All members of the team have extracurriculars and other projects, thus time to work on the project is limited.

Sending 1 kg of material to the ISS costs around $45,000. Making the robot light will allow for cheaper transportation to the ISS.

The propulsion system must resemble that of an octopus.

We cannot buy high end materials, since it wouldn't be economical for us as a team.

THE TEAM

- Mathew Panikowski
- Teacher - George Ouimet
- Senior Year At Frontier High School
- Hamburg NY
- Taught By Ouimet For 4 Years
- Pursuing Career In Aerospace
- Proficient In CAD

F.O.L.D.I.R.S.

F.O.L.D.I.R.S. stands for Fan Operated Line Detecting Infra Red System. It is the system that moves our robot back to the wall.

- Primarily X Axis Movement
- Uses 2 Same Way Facing Fans
- Uses A Battery And A Power Supply
- Can Be 5 - 12 Volts

OBJECTIVE

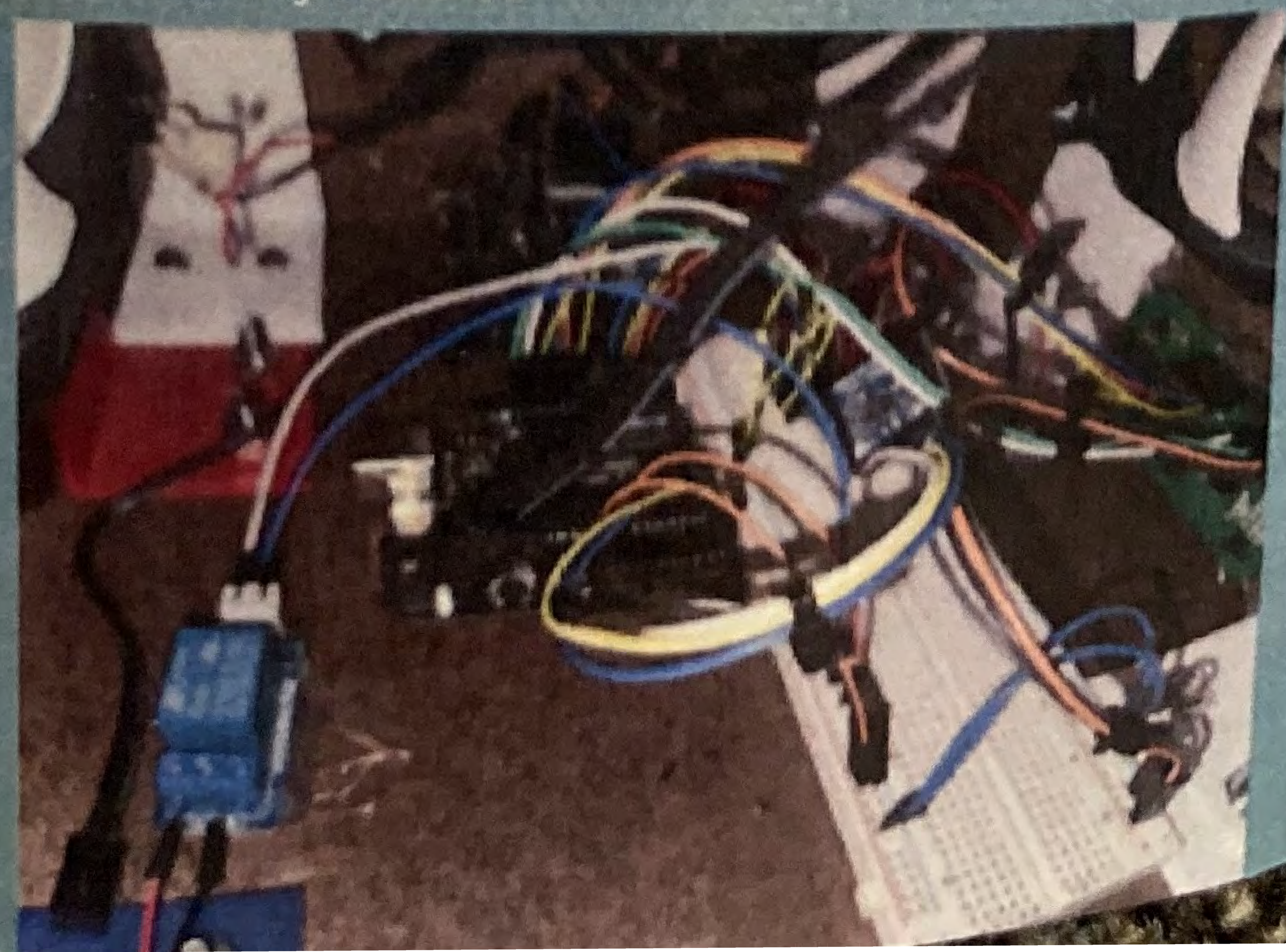
NASA has been concerned about cleaning and keeping the ISS clean for a few years now. The ISS gets dirty from dust and debris that occur when astronauts work on projects, eat meals etc. The addition of a soft bodied robot that is able to clean the ISS autonomaously will be a great help to the astronauts.

But how will this robot move? Propulsion of a robot in microgravity as well as the orientation of it is a tough problem to solve but not impossible. The propulsion of the Kwadropus has been my main objective for this project.

F.O.G.O.S.

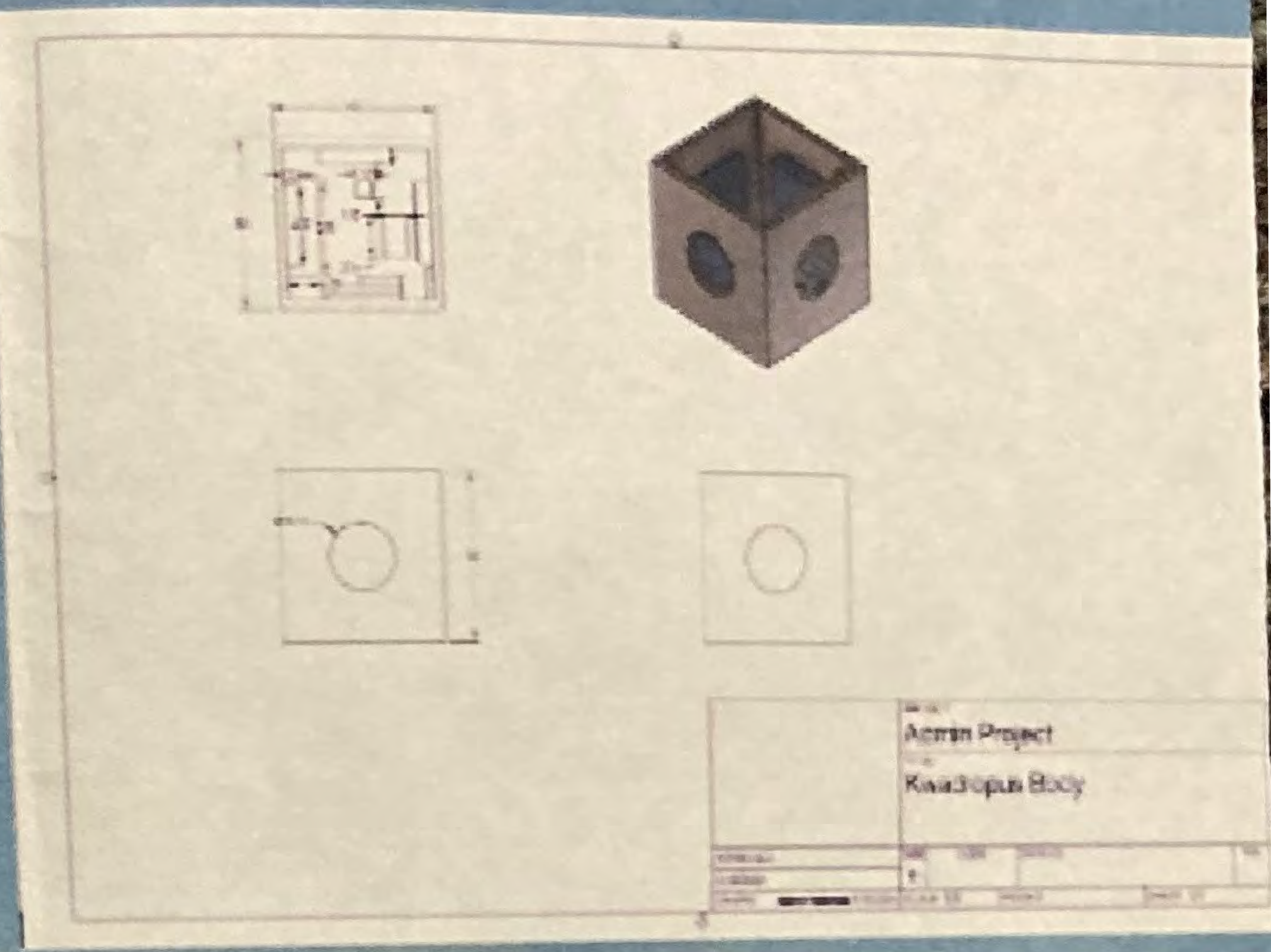
F.O.G.O.S. stands for Fan Operated Gyroscopic Orientation System. It is the system responsible for Orientating the Kwadropus.

- 2 Axis Movement
- 3 Axis Movement To Be Implemented Soon
- Uses A 3 Axis Gyroscope To Orient
- X And Y Axis Movement
- Fan Operated
- Battery Powered



DESIGN

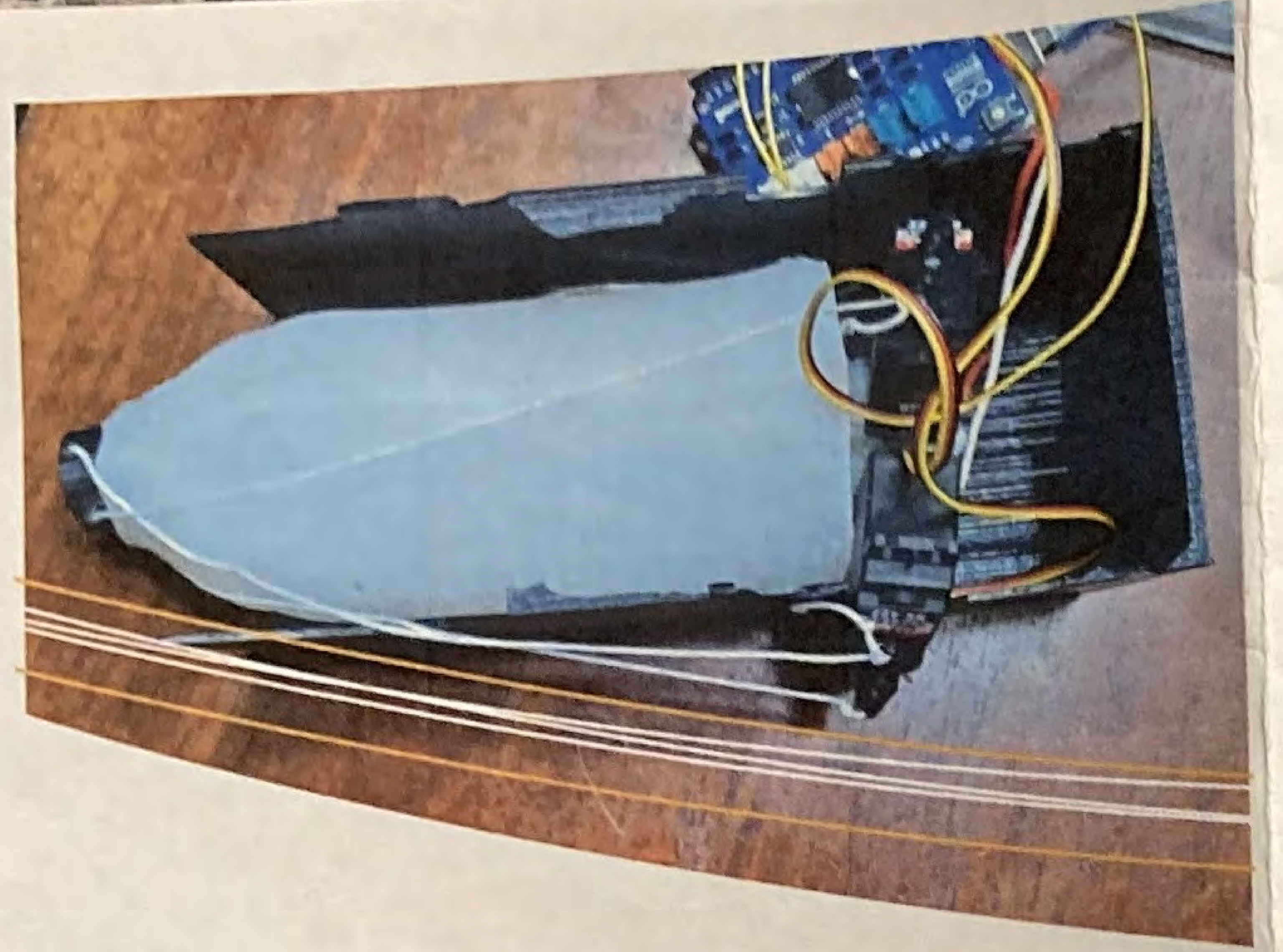
The whole robot and system were designed in CAD using Fusion360. The robot has been through multiple revisions but the model prototype you see today is show below in a CAD drawing.



Future Plans

The robot is still a prototype but is very close to being finished. A few upgrades and features need to be added to make sure the robot performs as requested.

- 3rd Fan For The F.O.G.O.S. System For 3 Axis Orientation
- Refine The IR Sensor System To Perform As Requested
- Power The F.O.G.O.S. System Using 1 Battery
- Upgrade The Frame Of The Body To A 3D Printed Body And Not Wood



Robotic Duster Propulsion System

Using movement methods straight from nature, our Octopuff effectively and efficiently propels, while sucking in air and sending it out.

Our robot is a soft-body robot made of silicone with a 3D-printed nozzle. Silicone was chosen as the material for the body of the robot because of its flexibility and durability. We have chosen to use strings and Servo motors to control our robot. Strings are soft and easy to use to pull our robot and the motors are small but strong enough to pull the strings. We are using PLA filament for the nozzle because it is accessible and easy to use for 3D printing. This robot will have a one-way ball valve for the output air and flap valves for the input air.

Innovations:

- String to gimbal nozzle
- One-way flaps to prevent the air from leaking
- Servo motors to control the strings
- One-way ball valve to control airflow
- Soft silicone body

Testing Data

Cycle	Seconds
Exhale	1.2
Pause	0.15
Inhale	0.725
Pause	0.15
Total:	2.525
Range	
Servo range	180 degrees
Steering range	12 degrees
Volume	
Volume full	183.5 cubic centimeters
Volume compressed	129.1 cubic centimeters
Mass	
Thrust mass	1.29 grams
Mass per second	0.511 grams

Future Steps For The Octopuff

- Additional testing
- Find ways to increase efficiency
- Add valves to intake holes
- Calculate force and angles for directions
- Additional collaboration with controls team
- Add ball valve to nozzle

Theo
Plano, Texas
Abigail Siefert,
Sam Martin

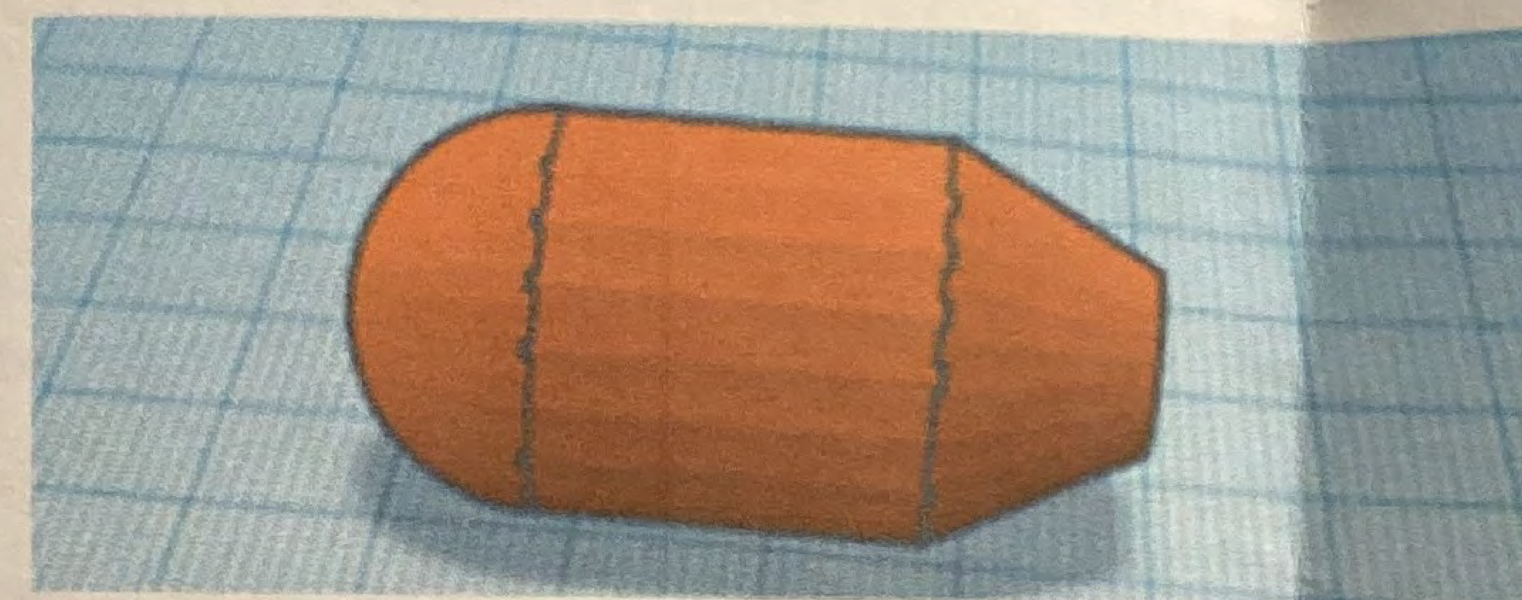
https://t.ly/ebR5a

Robot Design Evolution

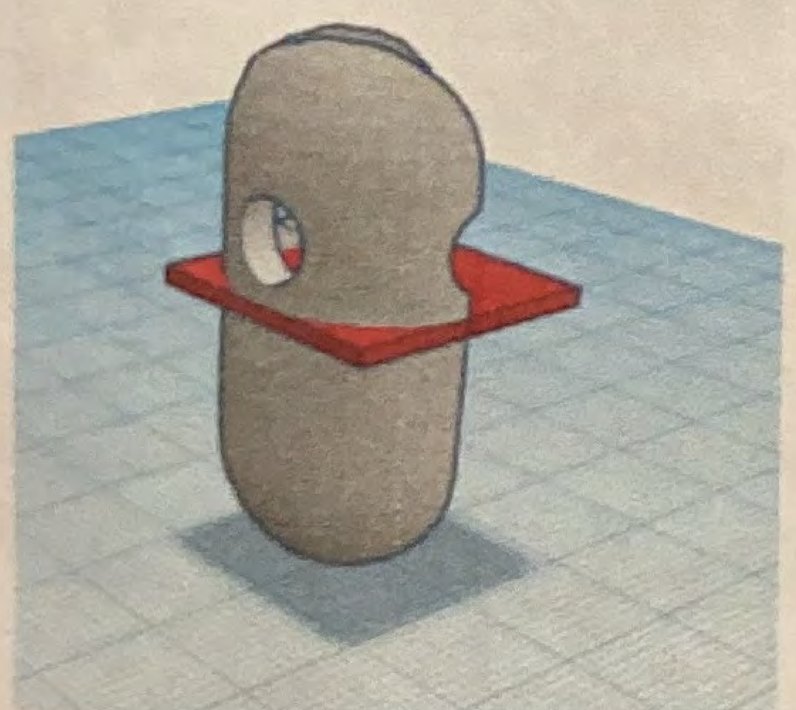
SOFT-BODY ROBOT PROPULSION SYSTEM

This robot has gone through many changes during the design phase. It has changed from a soft body with many valves, to a single-valve robot with a metal frame, to a simple silicone body with strings and a one-way ball valve controlling the airflow.

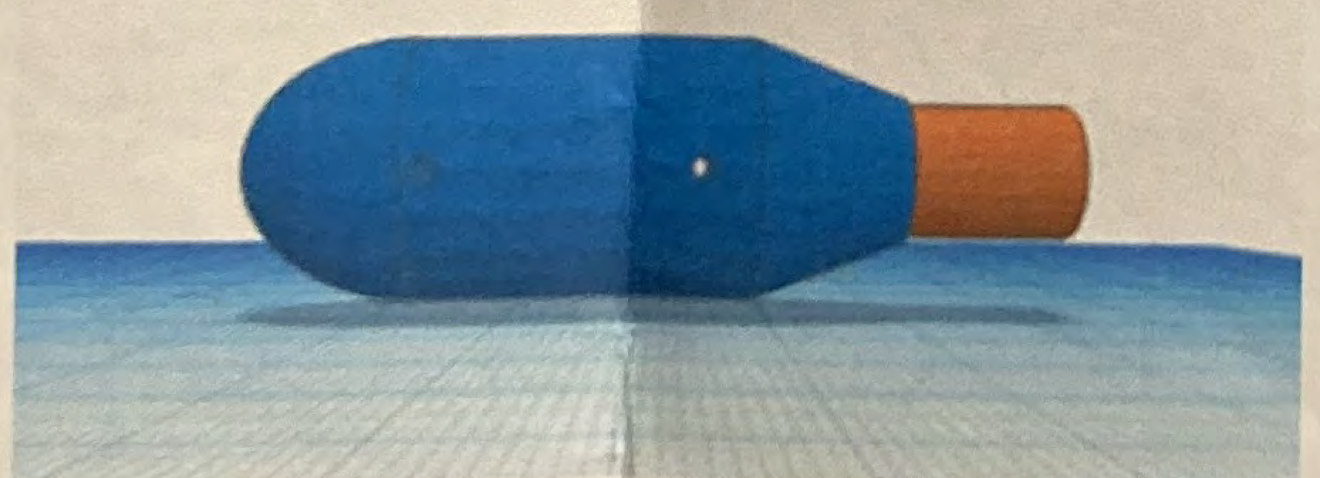
Soft-body prototype with many valves



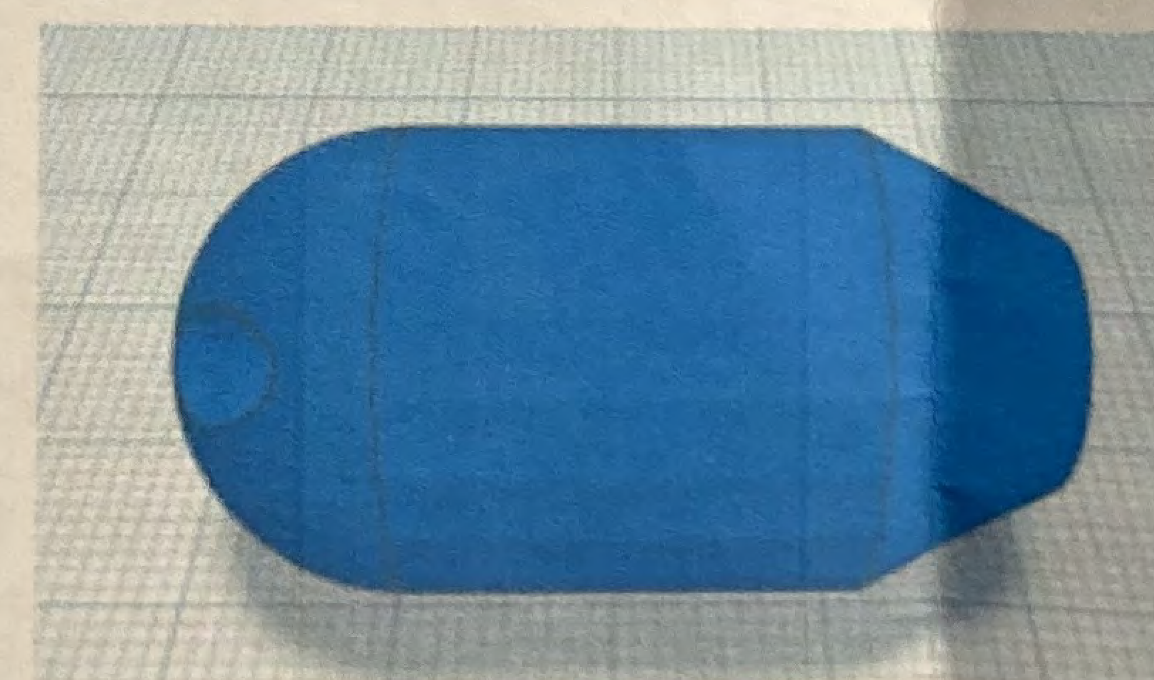
Simple valve-less prototype



Two-chamber soft body prototype

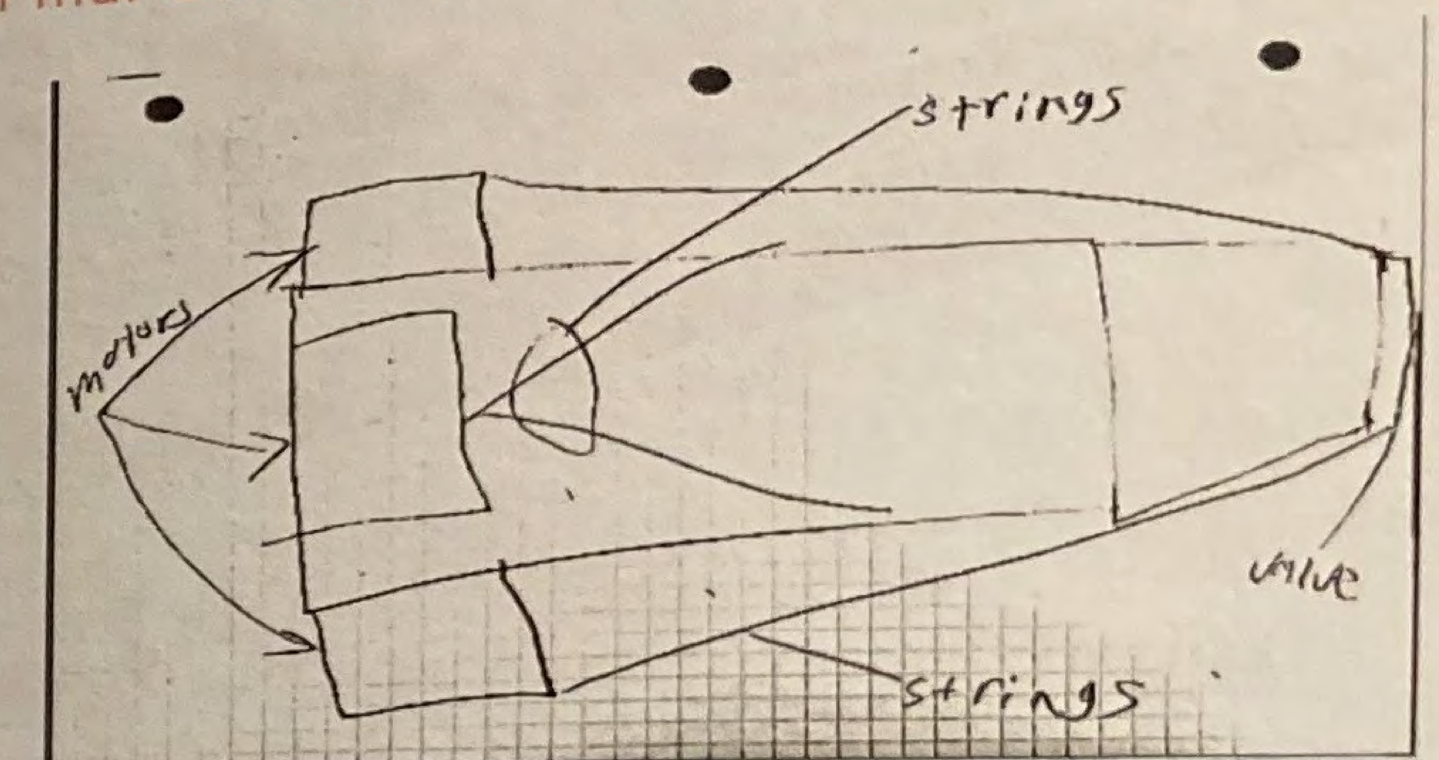


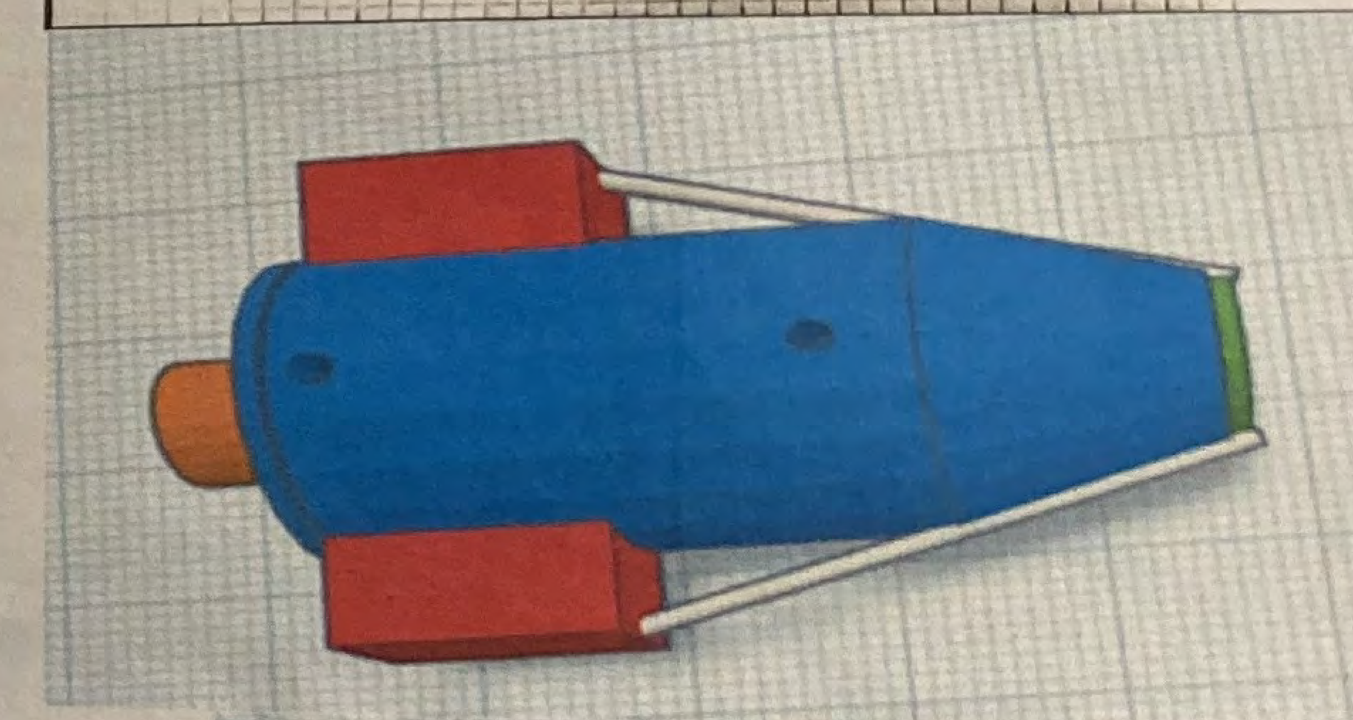
Soft body prototype with air holes and valve

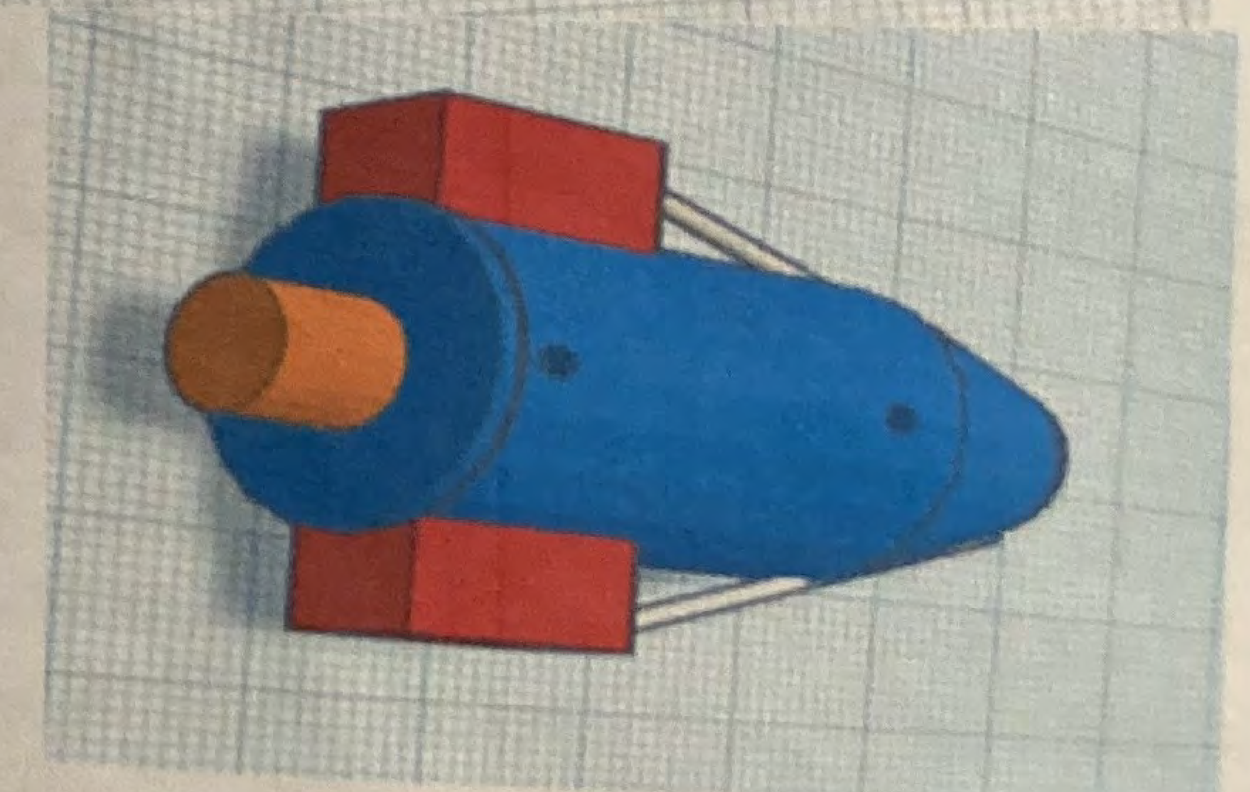


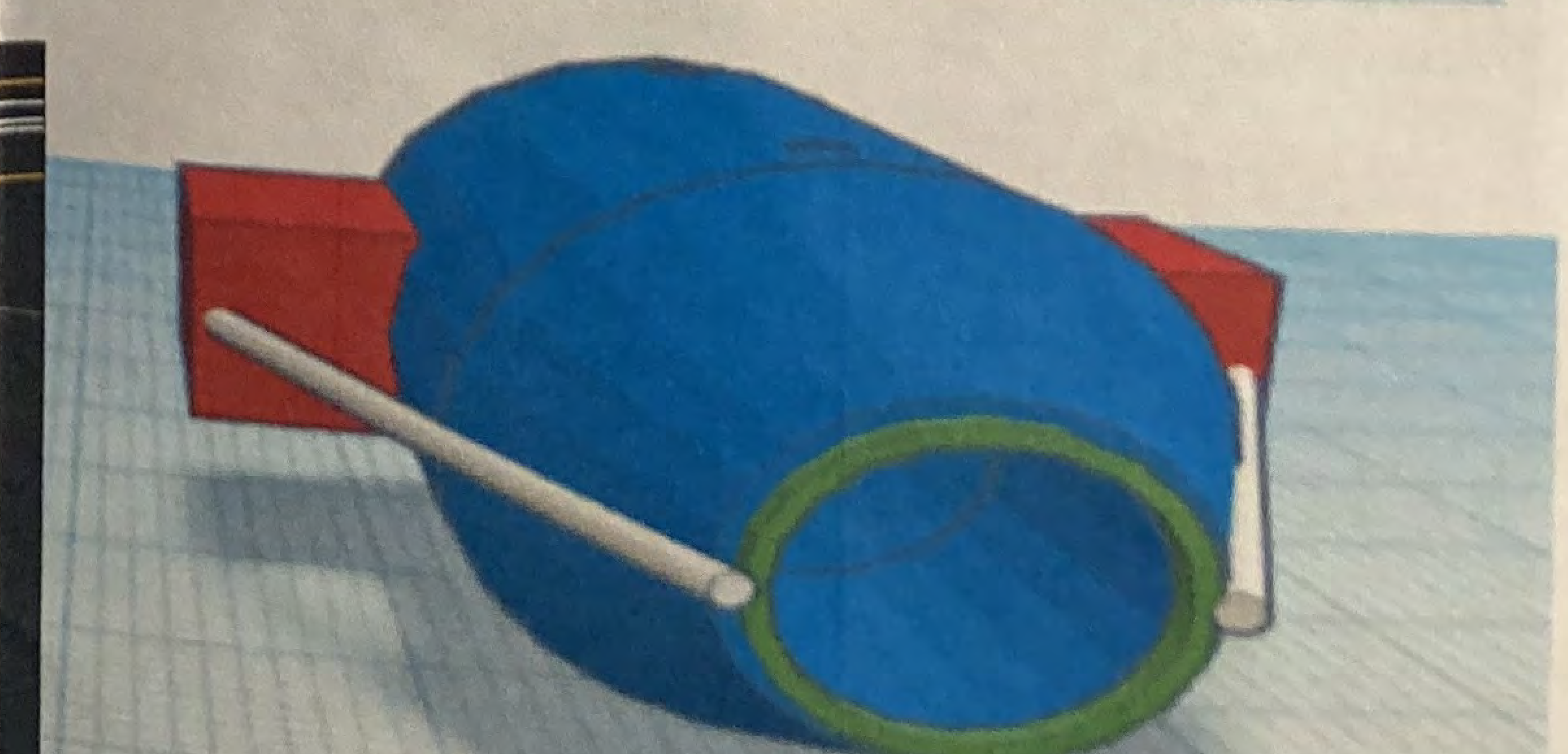
Soft body prototype with air holes

Final Conceptual Diagram and CAD Drawings









Initial Brainstorming

A cage around the air chamber will allow more stability and protection for the air chamber. This will allow us to connect all of our mechanisms to each other and make a structurally sound mechanism that propels the machine in the ISS. It will also allow us to securely connect the directional mechanism to the bottom.

A spot on the side of the cage around the air chamber to hold the motor will add security and stability to the entire project. It will give a spot for the motor right next to the air chamber to close it most efficiently.

A Controller to achieve directional movement will allow the person to control the direction of the air flow of the duster to allow it to navigate throughout the ISS. We also want to add a tube right where the air gets pushed out so that we can push the air in the direction we want.

Materials We Used

In our project the materials included 3D printed materials and metals to make a holder to the air reservoir and a holder for the strap.

We used a strap to go around the air reservoir and tighten it so it can push air out of the canister to push our mechanism.

We also used a 350 rpm motor to power the strap to make it wrap around the air reservoir and make it tighter to push air out so it can cause propulsion in the space station.

We also purchased a CPR mask as our air canister. We decided to use that because it was made out of a soft material so it is easier to push the air out of it with the strap and motor.

Propulsion System

Jesuit College Preparatory school

Mr. Couvillon

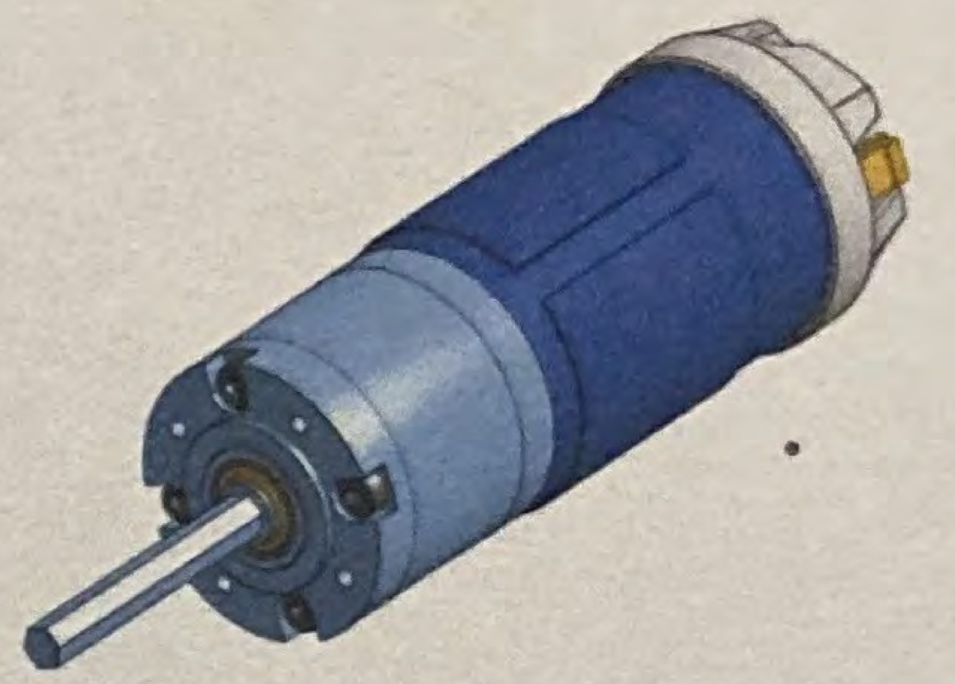
Michael Light, Noah Pinkall, Zach Pollock, Javier Marichal

Problems We Encountered

In this project we had multiple obstacles on the way to making our final product such as not having directional movement in our project. We realized that it would be very difficult to add that because it would add so much weight to the mechanism. We also don't know where or how to attach it to the air canister so it is sturdy but also right next to the point where the air is pushed out.

We were unsure of how fast the motor would go and if it could squeeze the air reservoir fast enough to push out enough air to cause propulsion. If it does not then it would not push the mechanism because there is not enough force to push it back to the wall.

Another problem that we encountered was the friction that was happening between the structure that held the air reservoir in place and the strap that tightened the air reservoir to release air to cause propulsion. The strap also didn't seem to work with the air reservoir no matter what, so the friction with the strap and the air reservoir caused us to take a different approach to the strap and how it's tightened.

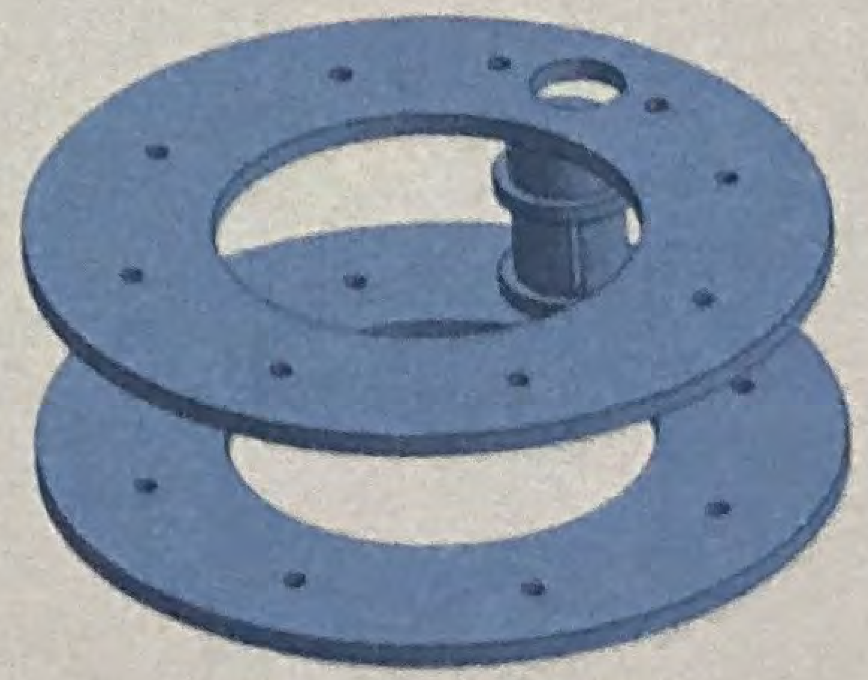


Our Solutions

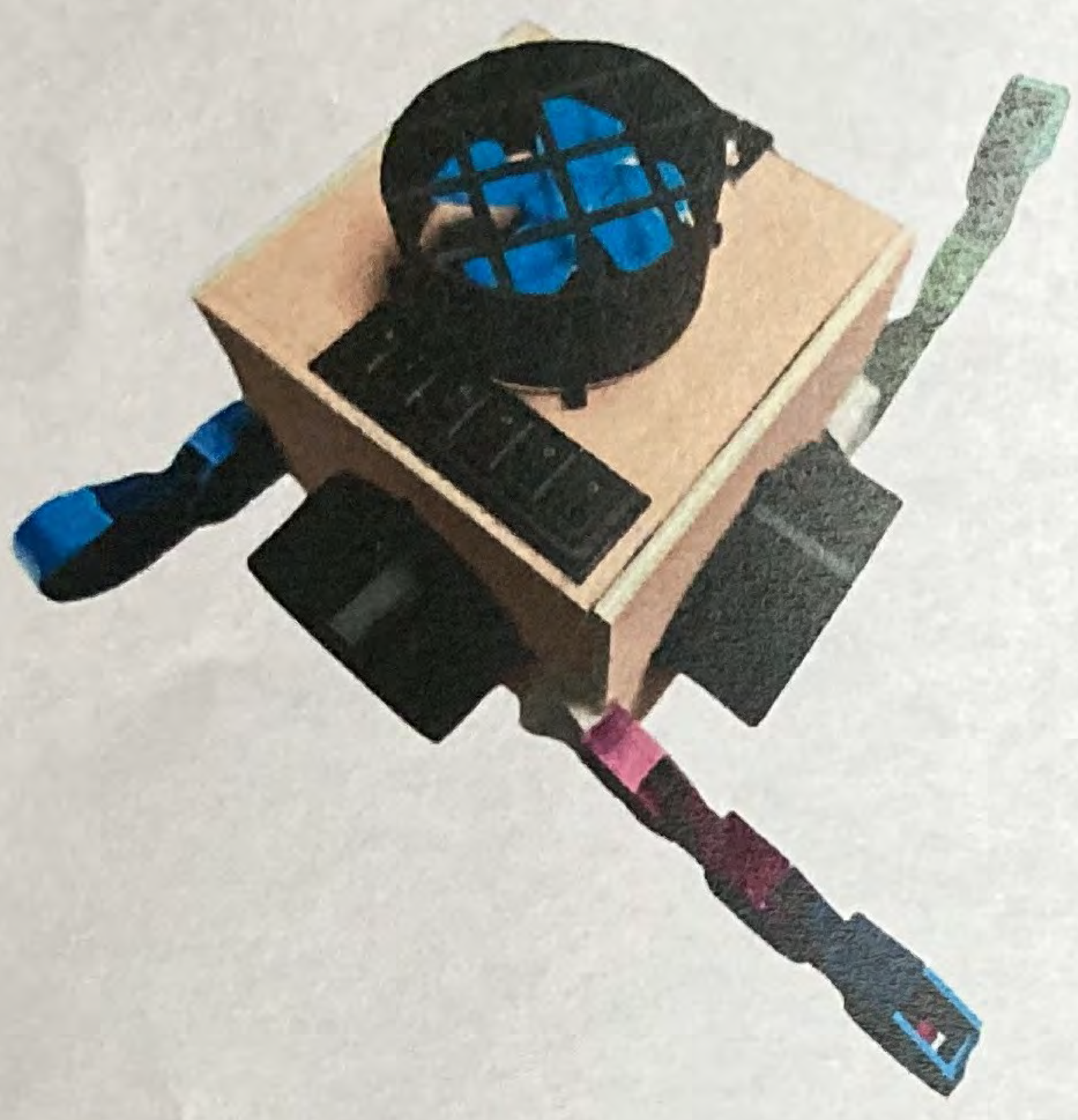
Our solution to the directional movement problem was to add a tube mechanism on the side of the air canister where the air gets expelled to control how the whole mechanism moves and the direction of it. We decided to 3D print a contraption that perfectly fit the neck of the air canister so it would fit perfectly so we could easily attach the tube. We will attach servo motors to the soft tubing so that we can control its direction.

A solution to the problem of the motor not being strong enough was to update our strap mechanism. We decided that a larger strap mechanism will pull the strap and twist it quicker so it pushes air out a lot quicker.

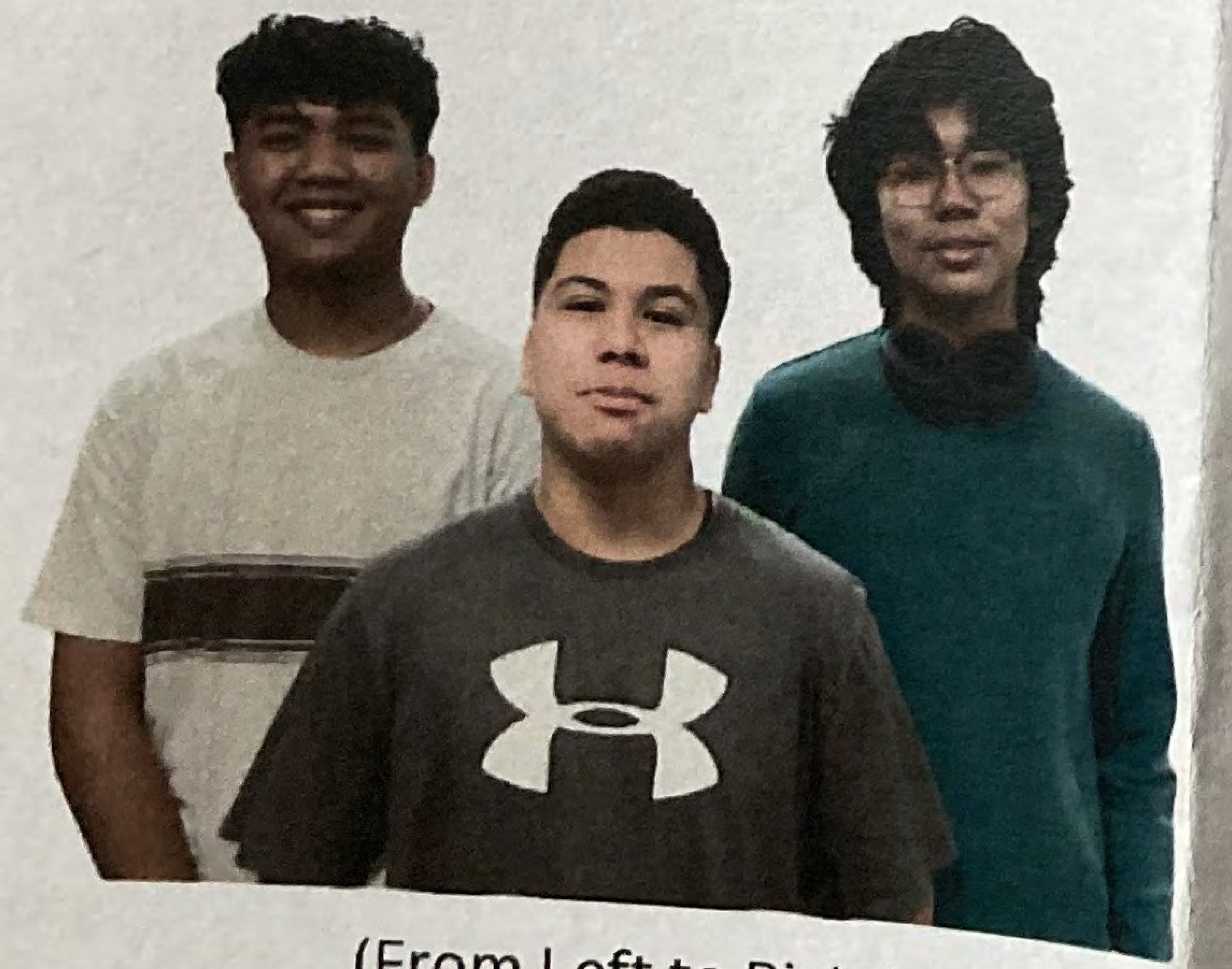
Our solution to the strap not working with the structure that held the air canister was to completely redesign the contraption all together. We remade it with wood to make it more secure and redesigned the engine holder to allow it to easily pull the strap.



KWADROPUS PROPULSION



Cypress Springs High School
Mentors:
Mr. Marcus, Mr. Glenn Johnson



(From Left to Right)
Christopher Caratao, Victor Estrada, Telmuun Baasansuren

Our Project

Our project is Propulsion, where the goal was to make a propulsion system that will be able to move the Kwadropus robot back to a surface whenever it detaches. The solution that we came up with was multiple motor powered fans attached on each side of the robot. Our project consists of the Fan Guard, Fan Base, Fan, Motors, Wires, and Switches with the box itself. The fans are placed on each side of the box with the wiring inside and the power switches on the outside. Finally the Kwadropus arms are attached on the edges of the box

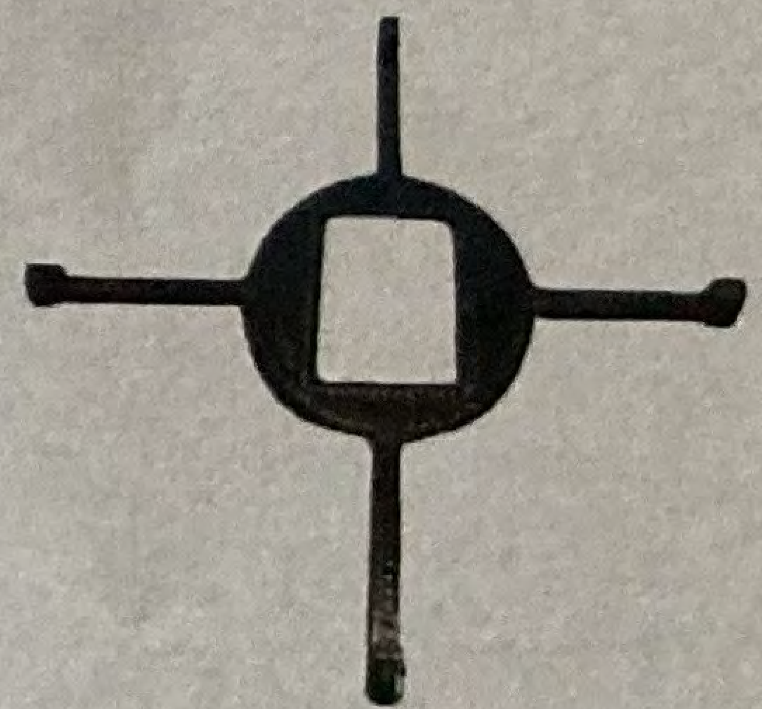
Prototype Desgins

Fan Guard

A cylinder like object with multiple strips a the top to protect the fan from any possib things that might collide with the fan itsel

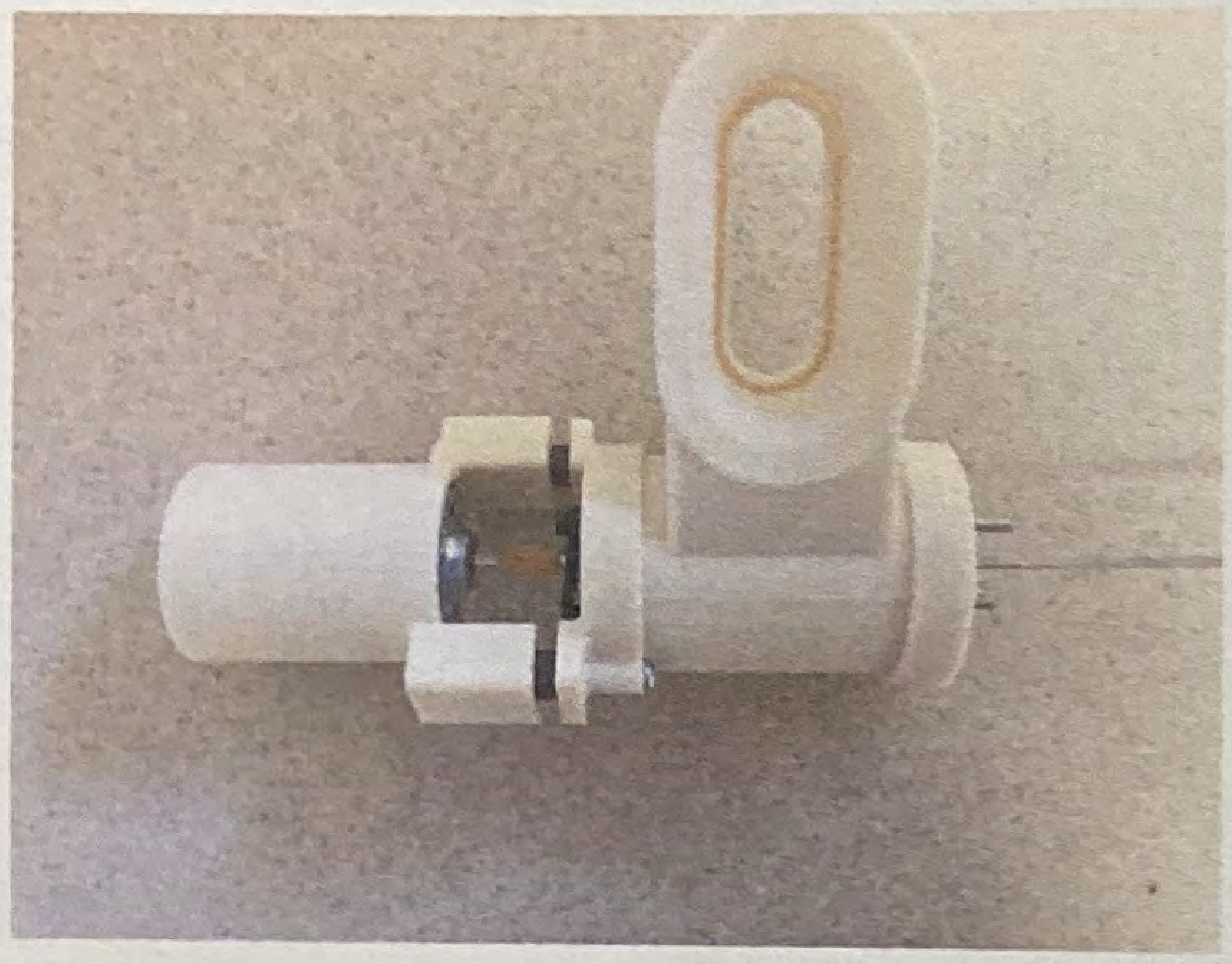
Fan Base

A cross that snaps to the base of the Fan Guard, the motor goes on top of the center o the fan base and connects to the fan inside



Kwadropus Arm

An arm that consists of multiple parts that are snapped on together to move. It replicates how the actual Kwadropus arm would be placed



NASA HUNCH

Kwadrapus Propulsion

By Michael Kramer and Narendra Punwasi

Our Members:

MICHAEL KRAMER
832-557-5120
100121011@ccisd.net

NAREN PUNWASI
713-367-6859
100045514@ccisd.net

Problem Statement

The Kwadropus is a robot octopus that uses suction cups and rails to get around in order to clean the dust inside of space stations. This group is tasked with figuring out how to push the Kwadropus back to the rail or a smooth surface when it gets knocked off.

Our group has come up with 2 porotypes for this task. One has to do with having a "bladeless"/squirrel cage fan; and the other has to do with saving up air in an air tank that eventually gets let out.

PowerPoint:

QR Code for Judges:

Group 2

"Bladeless Fan"/Squirrel Fan Prototpe 2

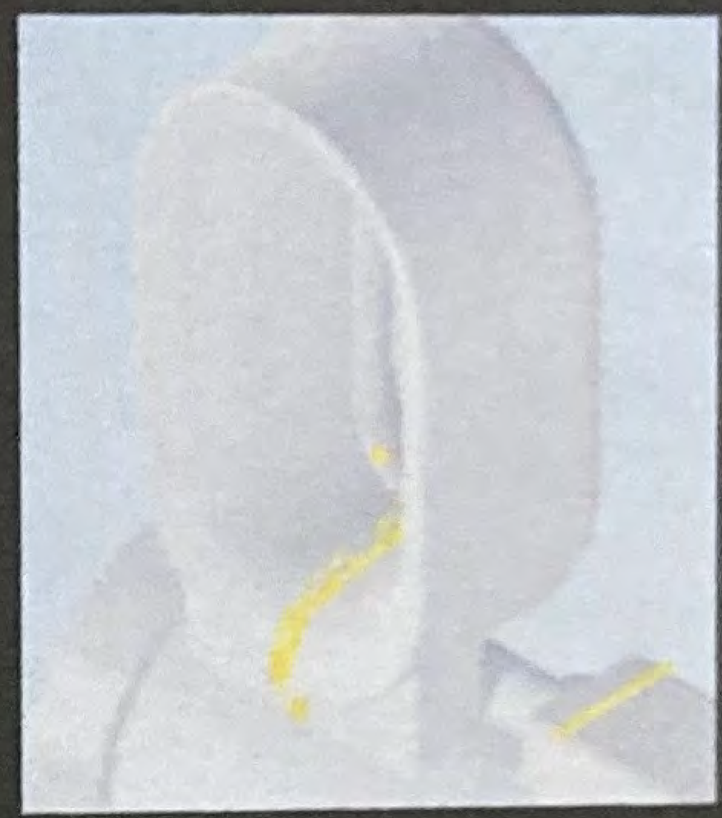
This prototype is a bit more advanced by having the motor directly attached to the fan assembly; and by having the torus directly made onto the fan blade. As the fan blade spins, it allows the air to exit through the torus (basically the same concept as prototype 1).
As well as making the fan easier to put together, having the torus attached to the case also allows for less air to be lost.

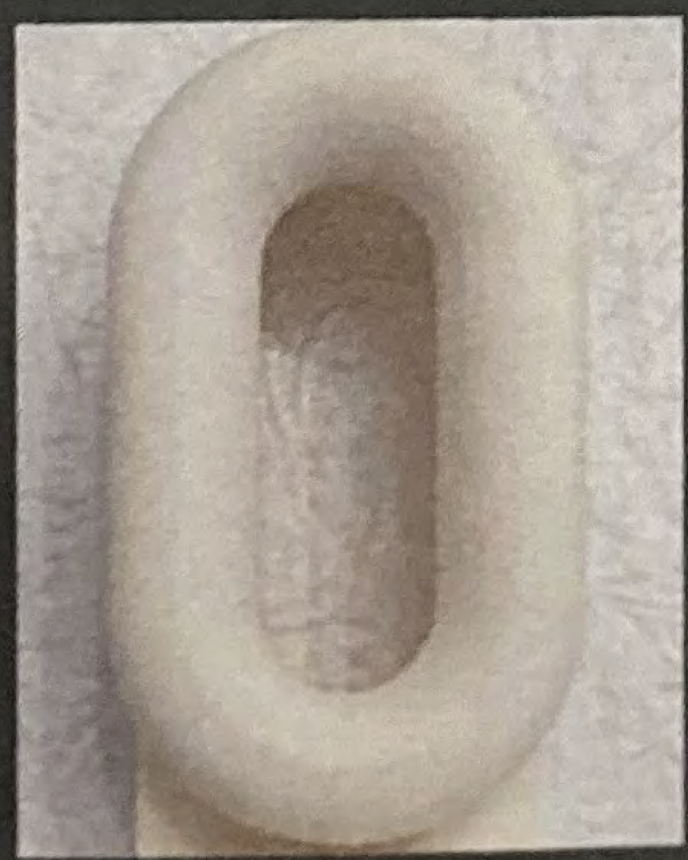
Prototype 2 Inside:

Prototype 2 Assembly:

Oval Tower:

This oval torus is used for both of our prototypes because it allows the outcome of air to be greater than the income. The shape of this object makes it so that the middle area has low air pressure; as a result, air has to be taken from the back and brought to the front to help combat that. This helps bring more force and power to aid our system.

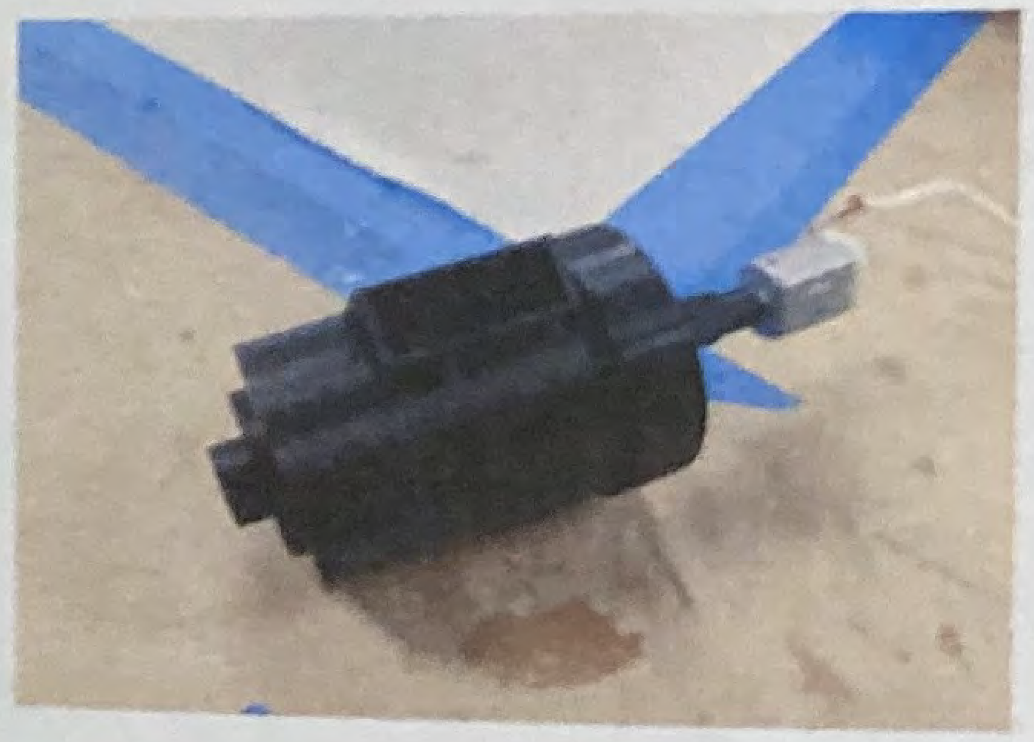




"Bladeless Fan"/Squirrel Fan Prototpe 1

Prototype 1 Inside:

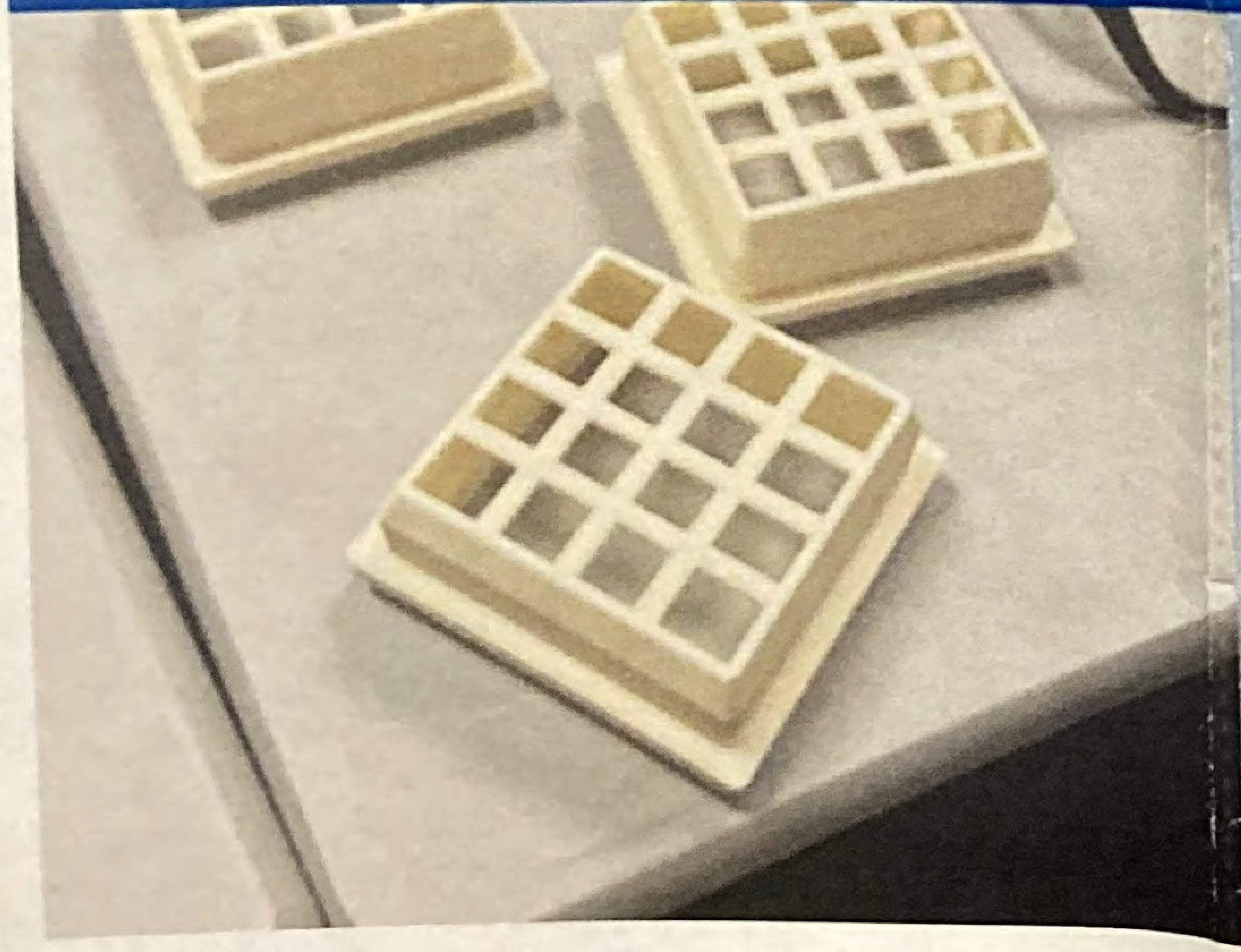
Prototype 1 Assembly:

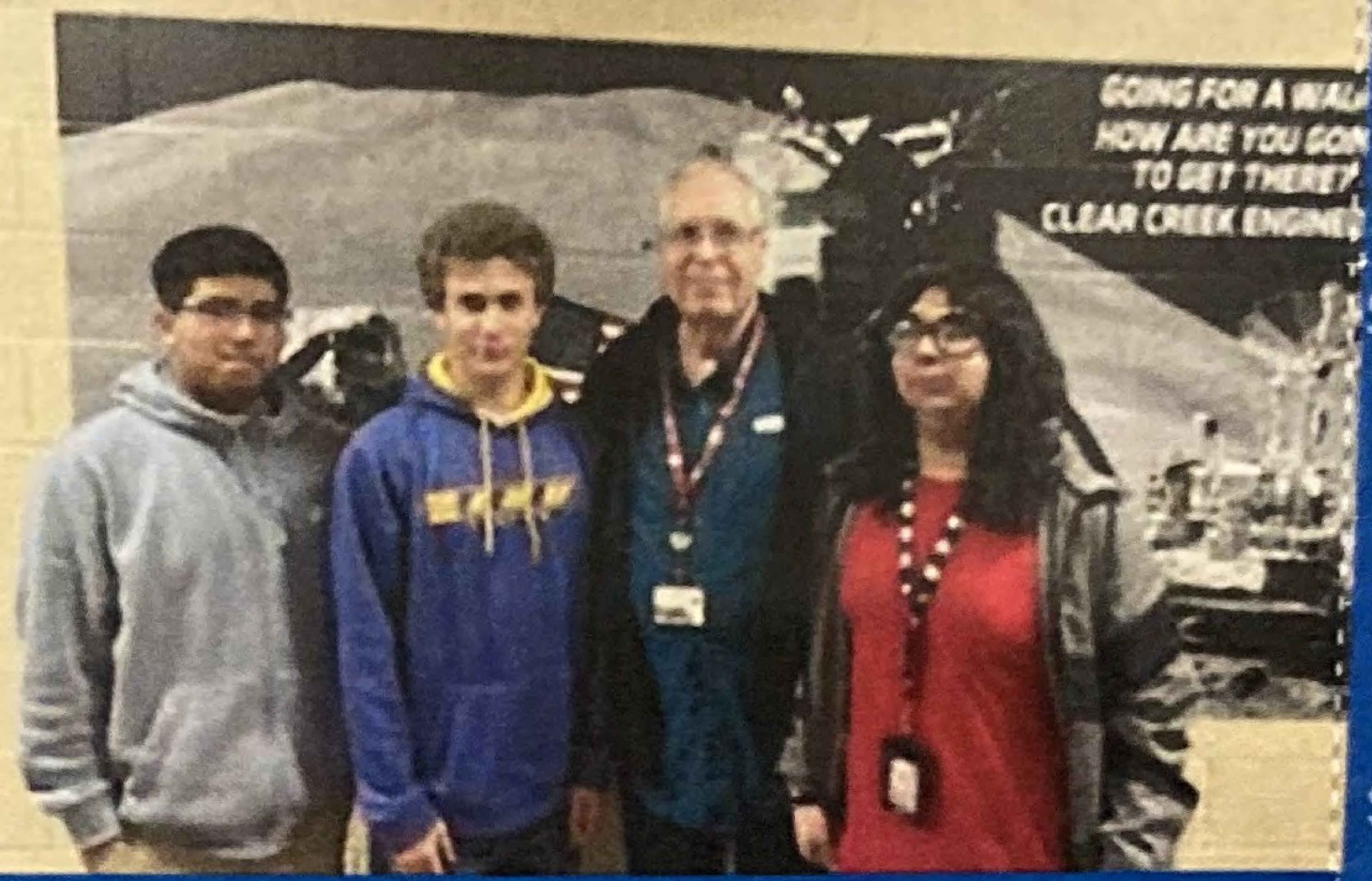


This prototype has a cage for the fan blades, and a motor that is connected to a custom piece to help spin the fan blade axle. As that spins, air exits through the rectangular prism, and into a detachable torus.

NASA
HUNCH

Propulsion
By Aiden Farrar, Xavier Infante, Anthony Harris
For: Mr. Merritt
Clear Creek High School
Engineering Design and Development



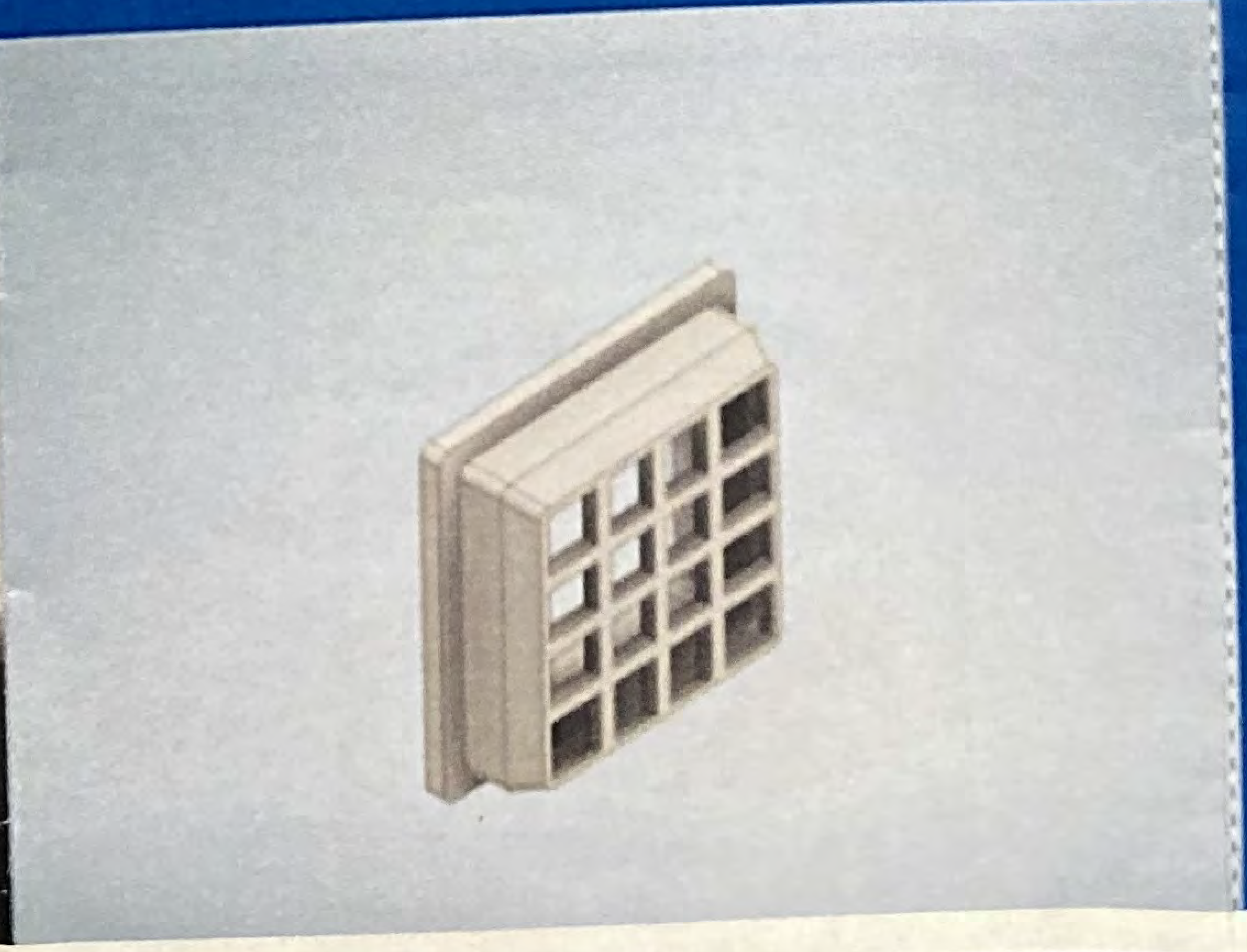


Contact us

Xavier Infante- (832)-713-0886

Aiden Farrar-(832)-627-6612

Anthony Vargas-(346)-617-0930



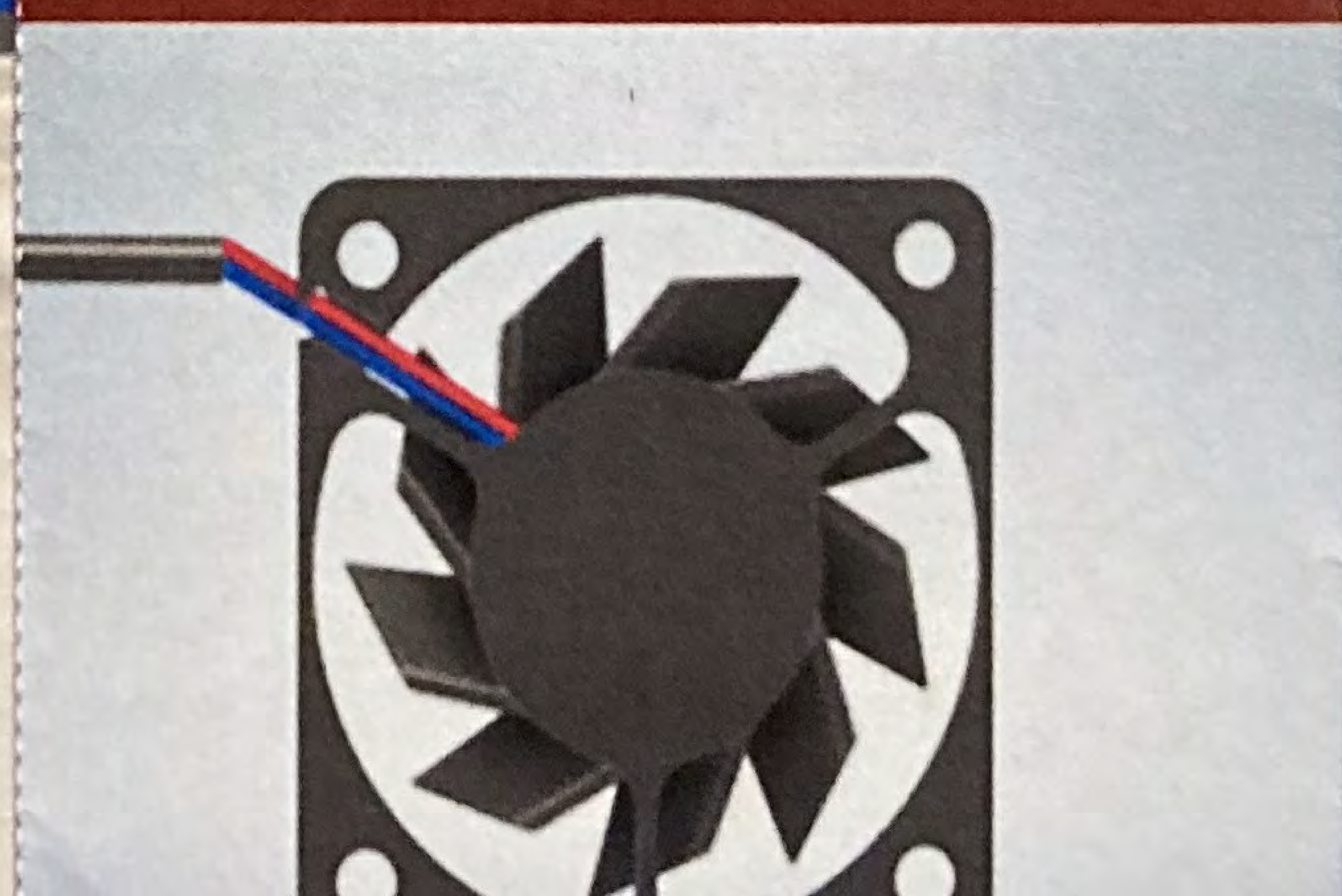
Octopuses live neutrally buoyant in t[he] water– they don't really sink and the[y] don't really rise up, they can rest in th[e] water without moving up or down. This [is] similar to how an astronaut floats arou[nd] in the Neutral Buoyancy Lab when the[y] train for a space walk on the space station. When astronauts are inside th[e] space station in micro-gravity, it is similar to being neutrally buoyant– the[y] don't sink or rise. The air has a lot less mass so it is very difficult to move enough air to "swim" when on the Spac[e] Station.

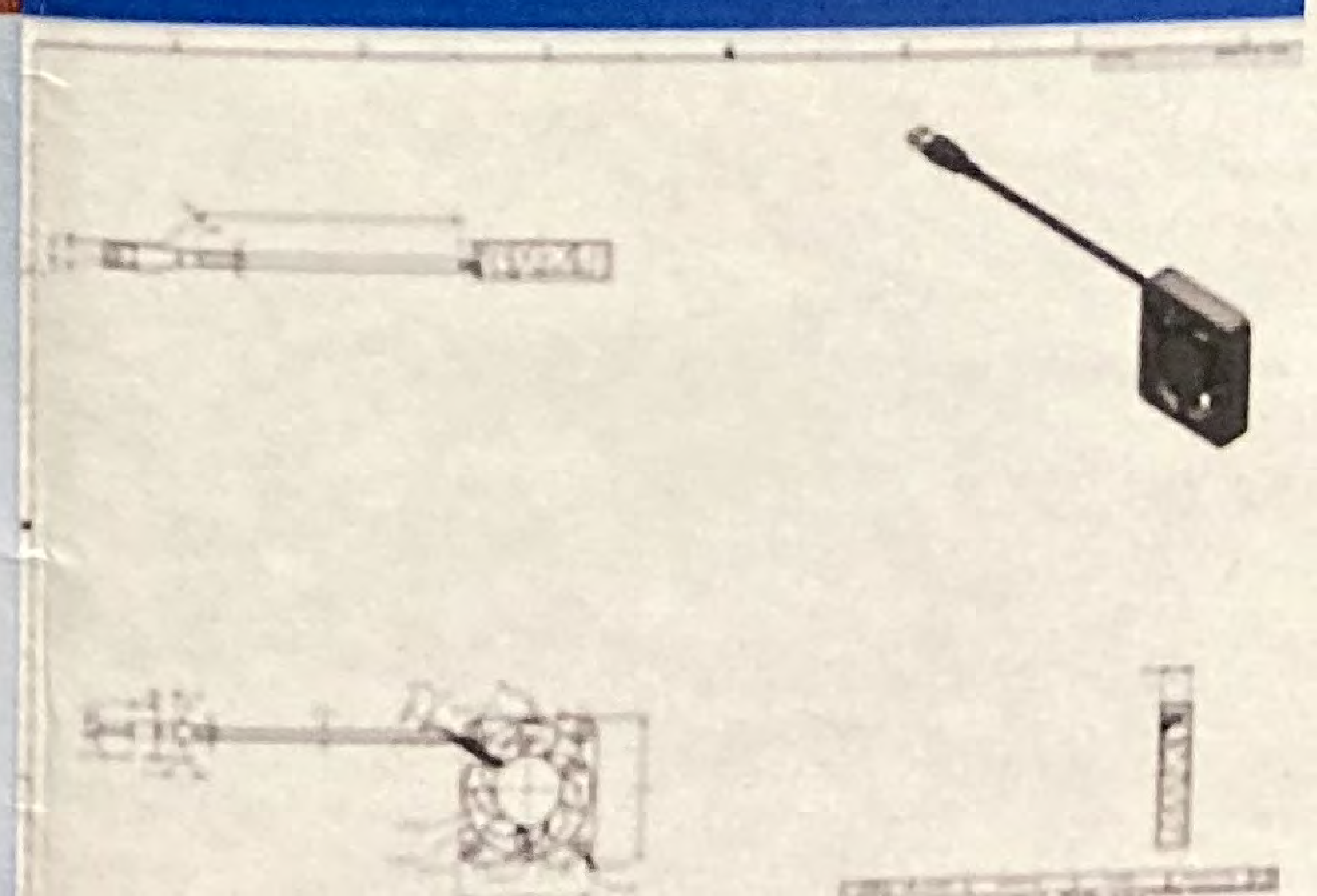
Our idea was to make a propulsion device that helps the Kwadropus navigate around the space station. The system is programmed to direct the kwadropus around the space station an[d] activate when near a wall or floor. Onc[e] activated, the kwadropus will be cours[e] corrected by the propulsion system.

The funnel will be inserted into the bottom and top of the casing surrounding the Arduino. It will be nserted into a cut out space to attach he USB to the Arduino. There are two propulsion funnels so that there is a afety mechanism for when the robot ets stuck at either the top or bottom of the space shuttle.

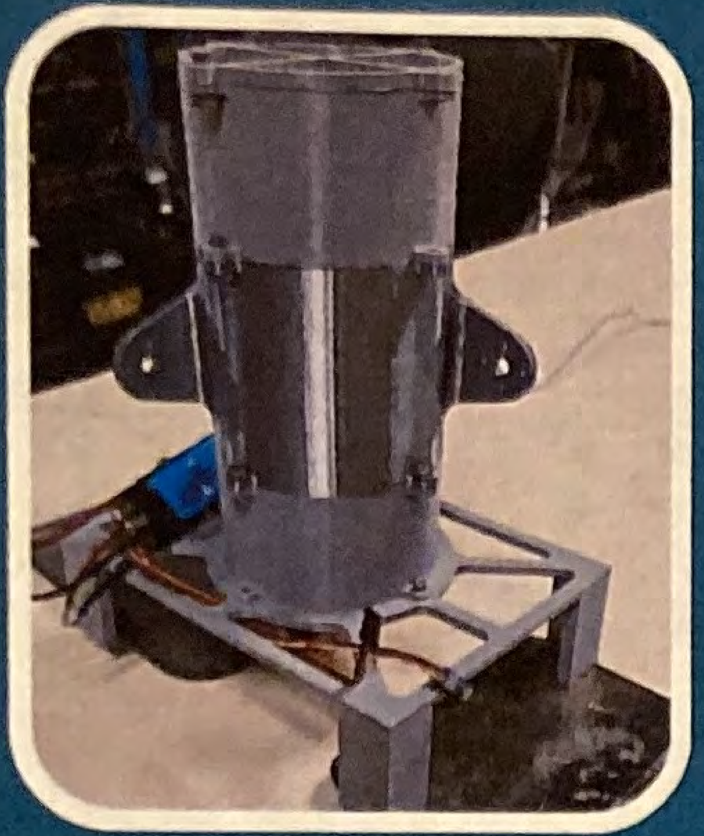
The funnel when activated, will shoot out a low amount of air to keep the robotic duster on course. If the duster reaches to close to the top or bottom of the shuttle, the funnel will activate.

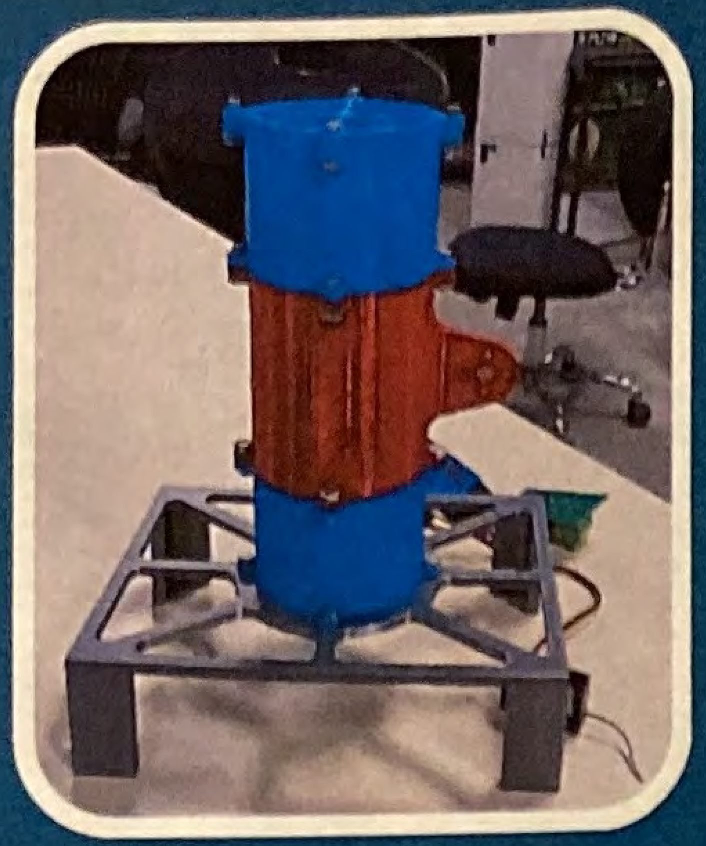
The funnel will be activated for a se amount of time. Once a couple of seconds have passed, the robotic duster will be recourse and the funn will turn off. It can be reactivated instantly but there will not be a neec as the duster will be put back on course.





Fabrication



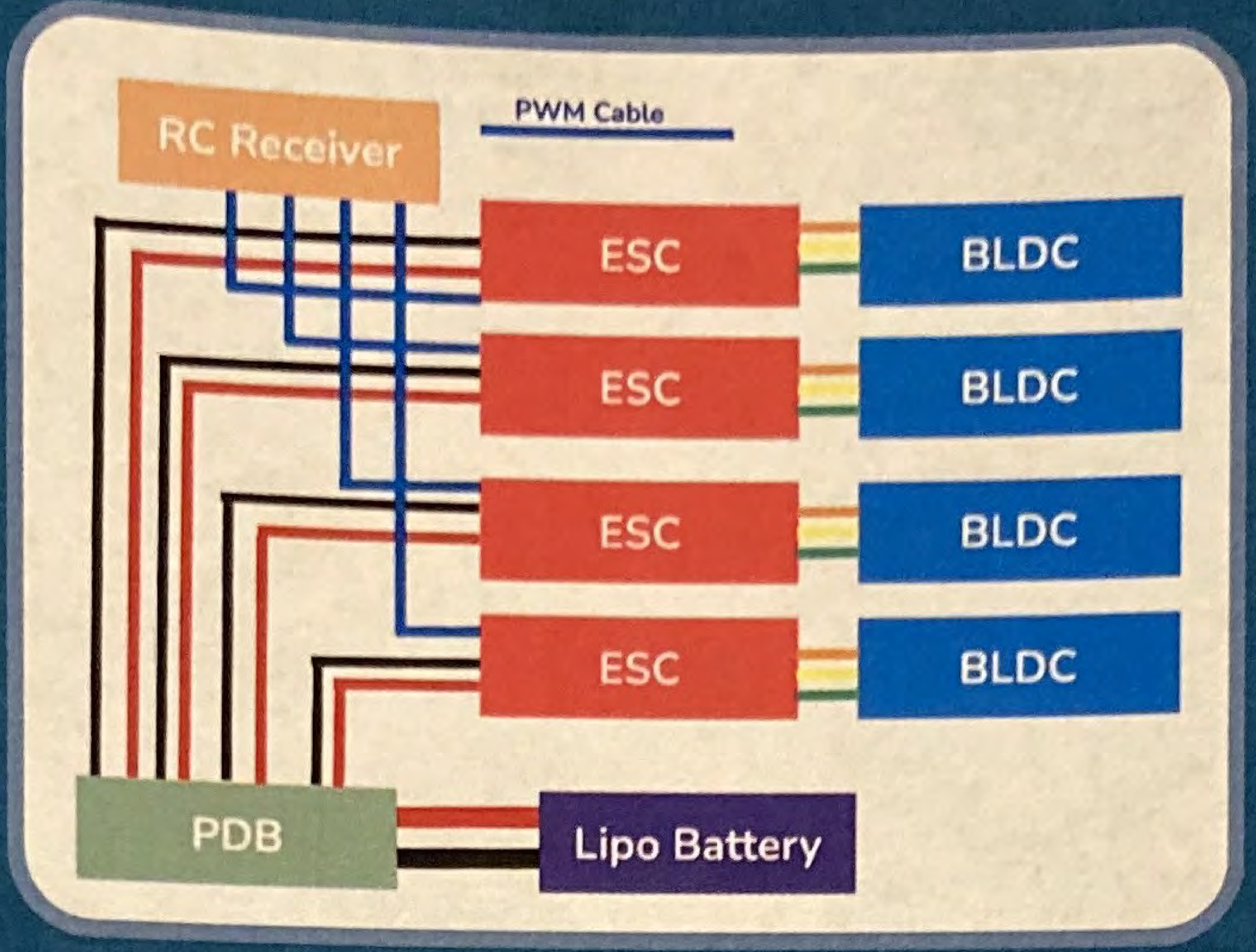


- 3D Printed in PLA
- 44 bolts for assembly
  - 16 for thruster tabs
  - 16 for motor mounts
  - 12 for reaction wheel mass

Full System Integration

Uses the grills and existing tabs to mount to the rest of the robot

Electrical



- PDB (Power distribution board) to connect all motor controllers to battery in parallel
- PWM cables for communication with ESC
  - Controlled through code or RC remote

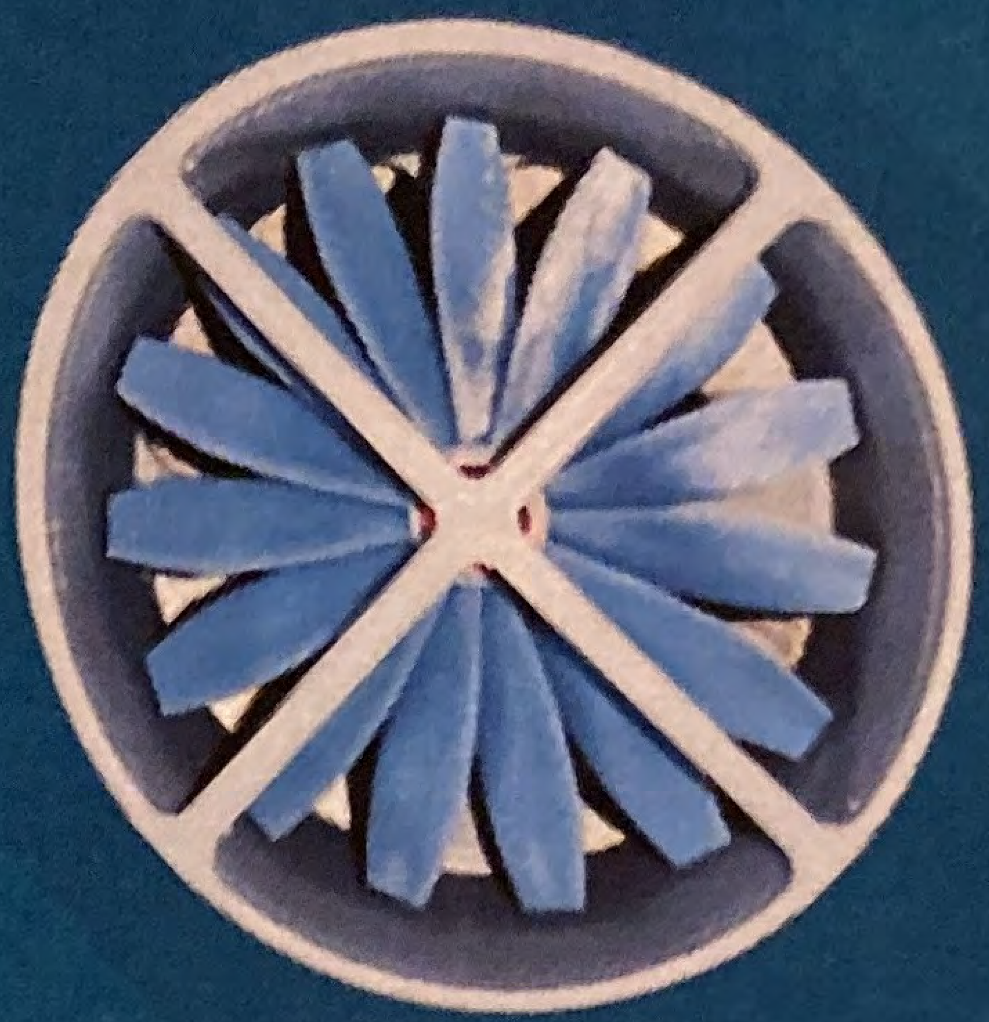
Additional Resources

Includes:

- Testing data
- More images of build and CAD
- Presentation explaining project
- Link to online CAD

Dust Thrust

Kwadropus Propulsion



Nate Knarr
Gabe Palmer
Keaton Hall

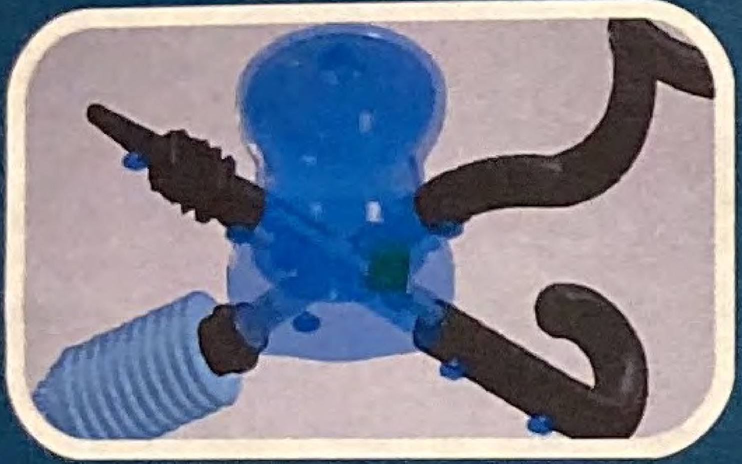
Michael Merz

Columbia Area Career Center
Columbia Public Schools

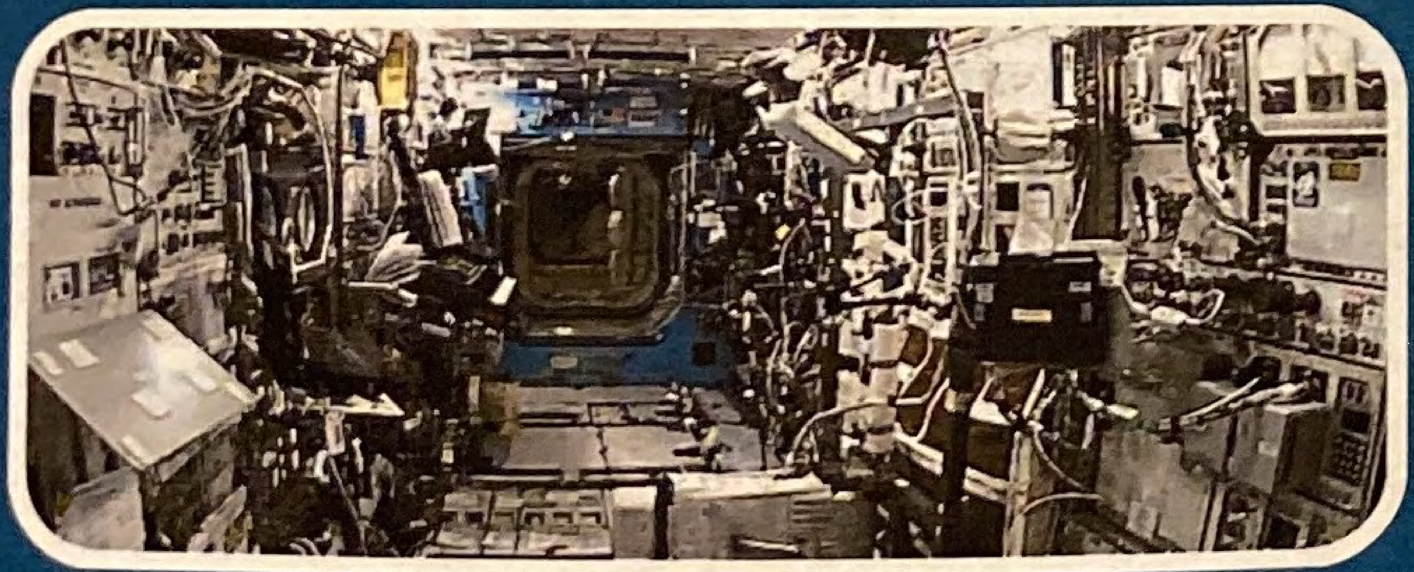
NASA HUNCH

Kwadropus Propulsion Subsystem

- The Kwadropus is a robot that dusts a space station
- The propulsion subsystem moves the robot through the air when not touching the wall

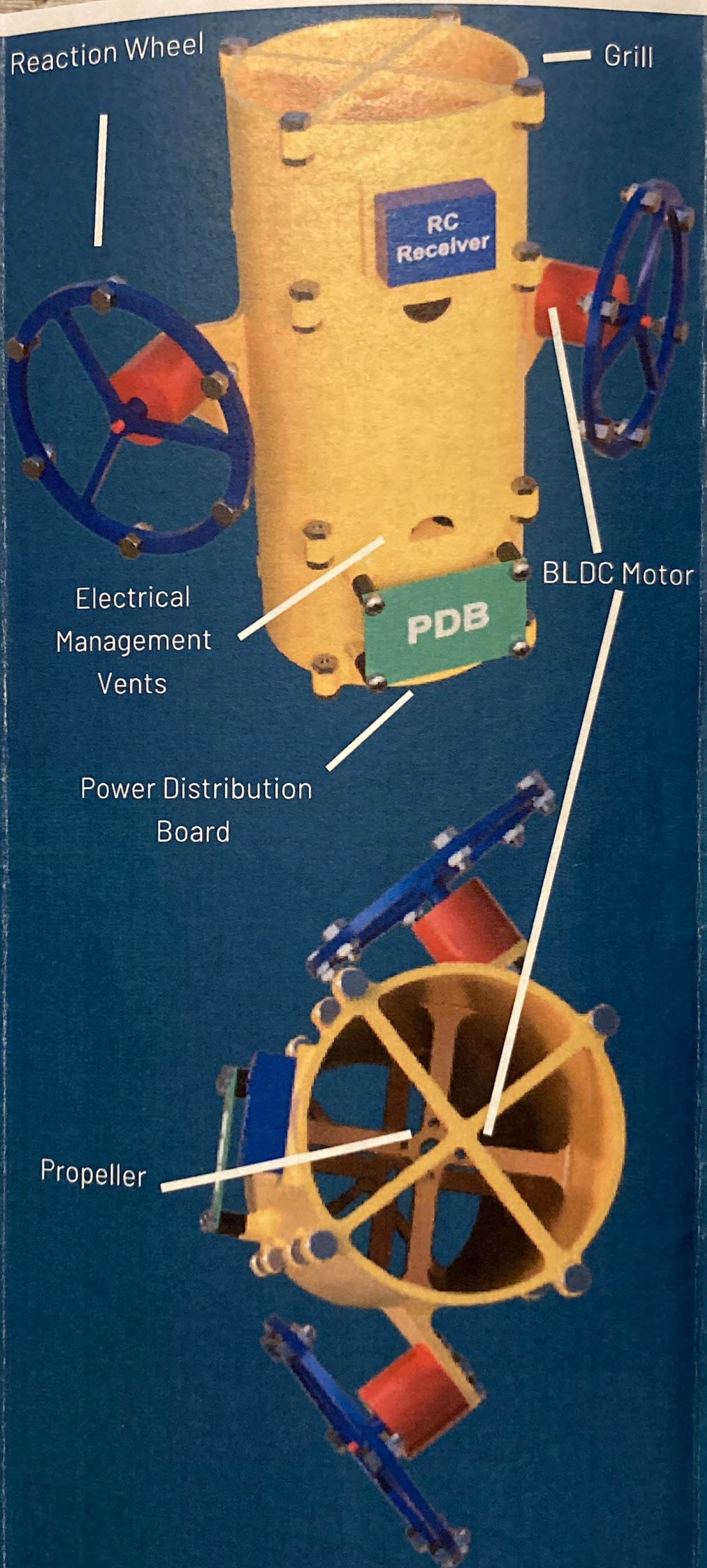


Full Kwadropus robot



Features

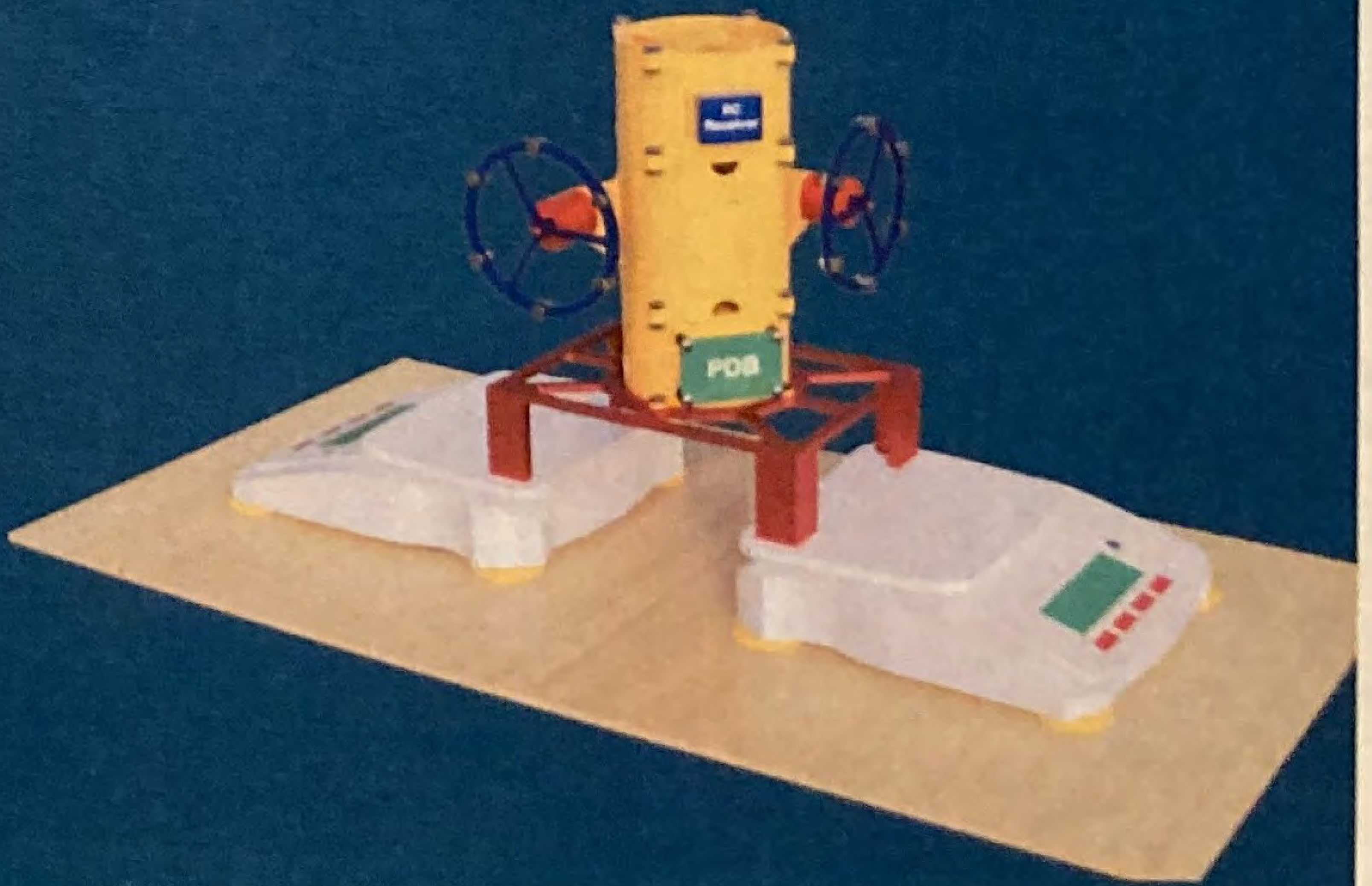
- 2 counter-rotating propellers for thrust
  - Double as a differential roll
- 2 Reaction wheels to control pitch and yaw
- Modular for easier assembly, accessibility, and prototype iteration



Data

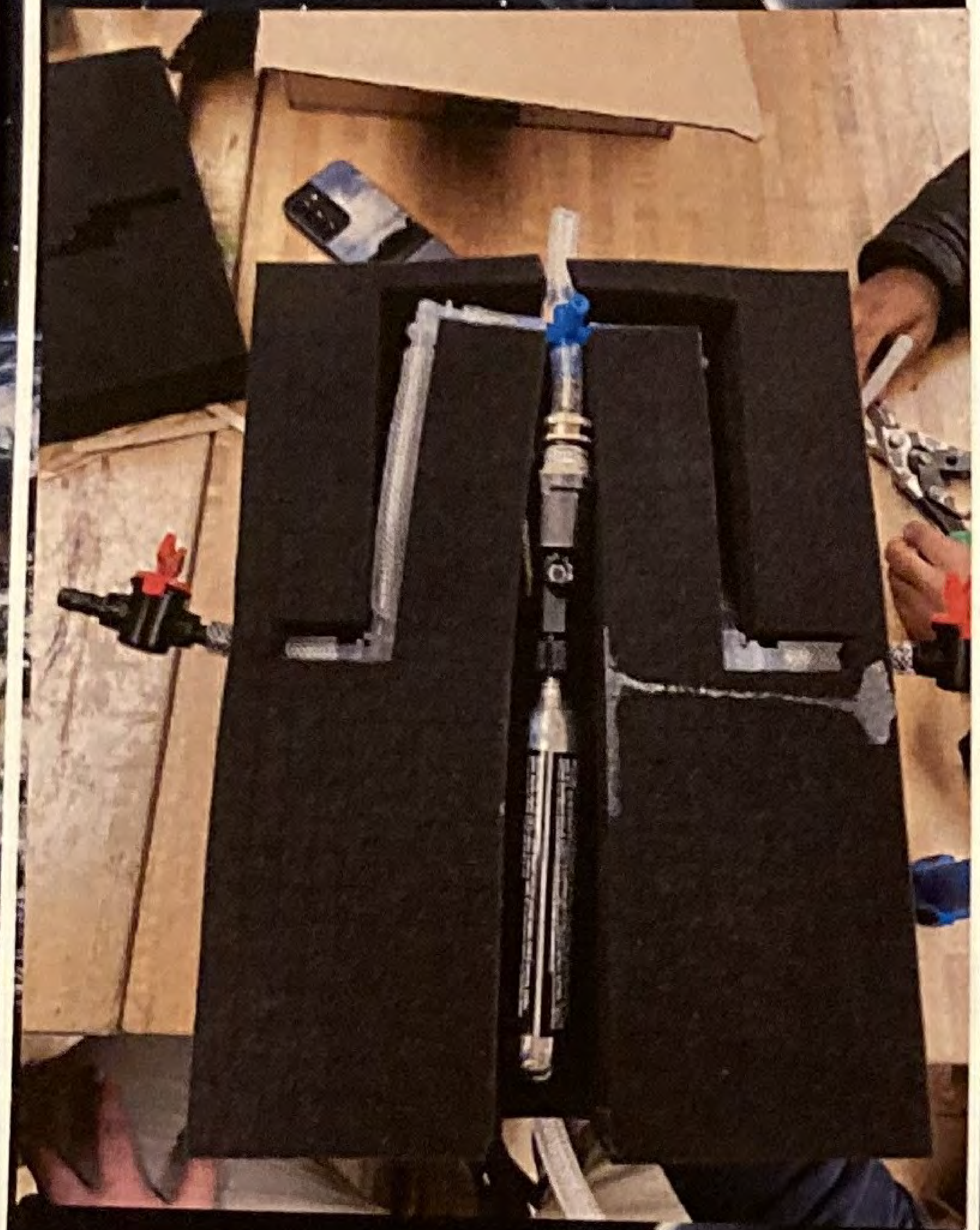
- **0.37N of Thrust**
  - 0.07m/s^2 of acceleration
  - Travel 3m (approximate width of space station) in 8.95 s from rest
- 2.3A draw
- **4.73 m/s airflow at 6in**
- All data at 15V with a 5kg robot for calculations

Testing Setup



- Span 2 scales for thrust measurement
- Consistent mount for air flow and power consumption test
- Attaches with the same mount as the grill t emulate the exact opening

PCTVS

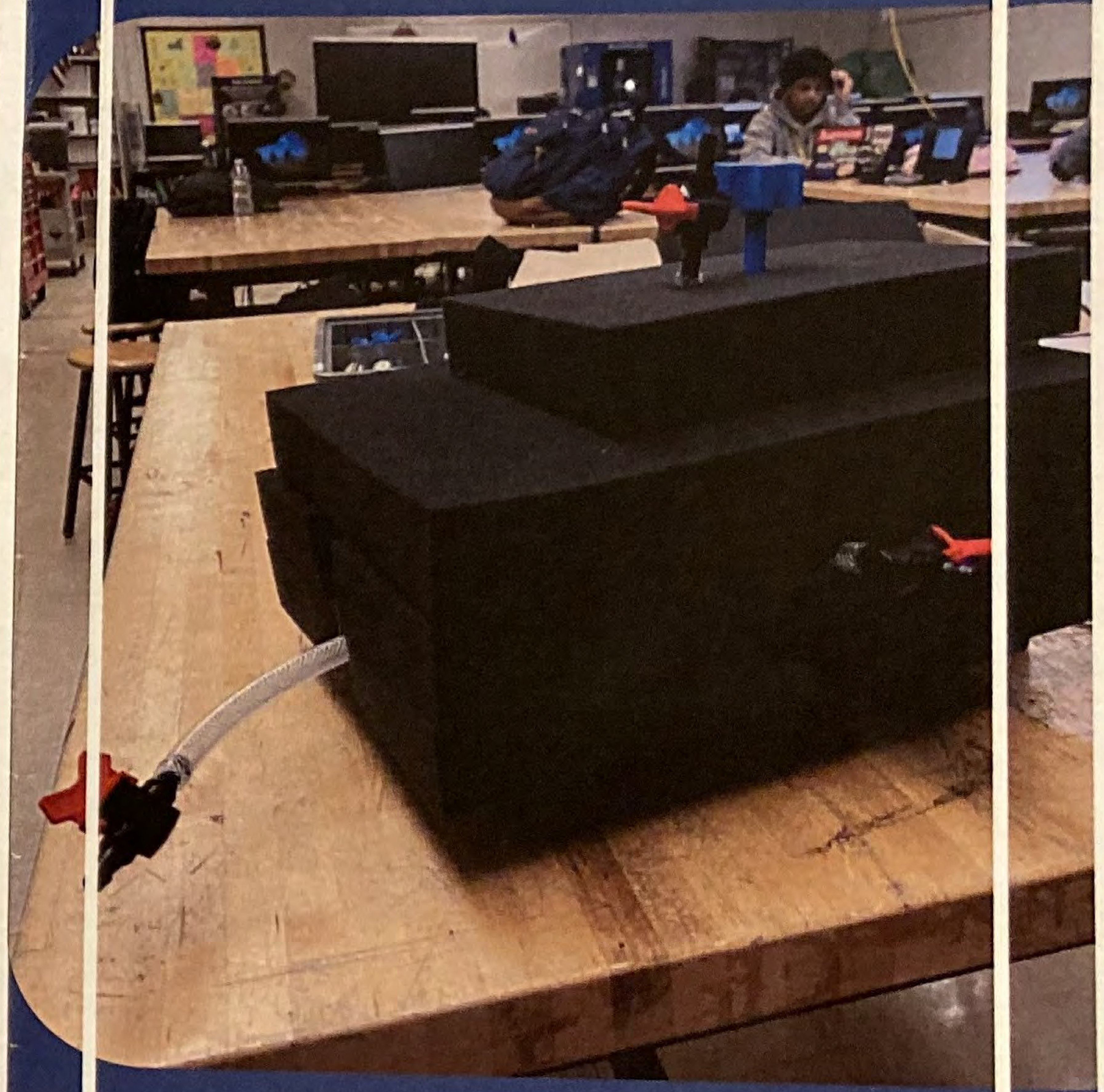


PROJECT LEAD THE WAY
PLTW

Passaic County Tech Institute Albarez 7-9

Meet the Team

NASA Hunch



Kwadropus Propulsion System

Purpose

To develop a propulsion system for the Kwadropus robot to move itself without grabbing or gripping a wall or handrail.

It will also return the robot to the wall if the arms and suction cups are not able to grab onto something.

Design

The design of the propulsion system is based on the MIT SPHERE and its carbon dioxide expulsion system to move the Kwadropus. The system works by shooting CO2 out of controlled valves that can be automated or controlled with a control switch. The design works in three dimensions and requires CO2 to function.

Criteria

Propulsion must:

- Propel robot in one or more axis
- Have the ability to push 10kg
- Incorporate a way to control the system
- Activate and reset at least 2x within 20 sec to push the robot back to the wall

Constraints

- Cannot use liquids
- Limited use of gasses (remain aware of any byproducts)
- Be soft and maluable (in case of collision with ISS internals)
- Will not twist or turn the robot through spin up or spin down of motors
- Air from system will be directed away from the surface being cleaned

How?

A carbon dioxide canister, connects to the robot via vinyl tubing. Opening the valves released carbon dioxide which propelled the robot into motion Our design is controlled by a basic circuit and joystick to decide which solenoid valve opens to determine the movement of the kwadropus.

Materials

- 8 Foams boards 3/8
- Air tubing
- 6 tubing valves
- 3D printed piece(7 way split)
- Co2 canister
- Wood glue

Propulsion Belt

Our design focuses on simplicity, creativity, and efficiency. Conscious of the manufacturing process, durability requirements, and costs pertaining to space travel, our design offers high performance in an easy-to-maintain package.

Testing QR Codes

Physics Cart Testing

Water Testing

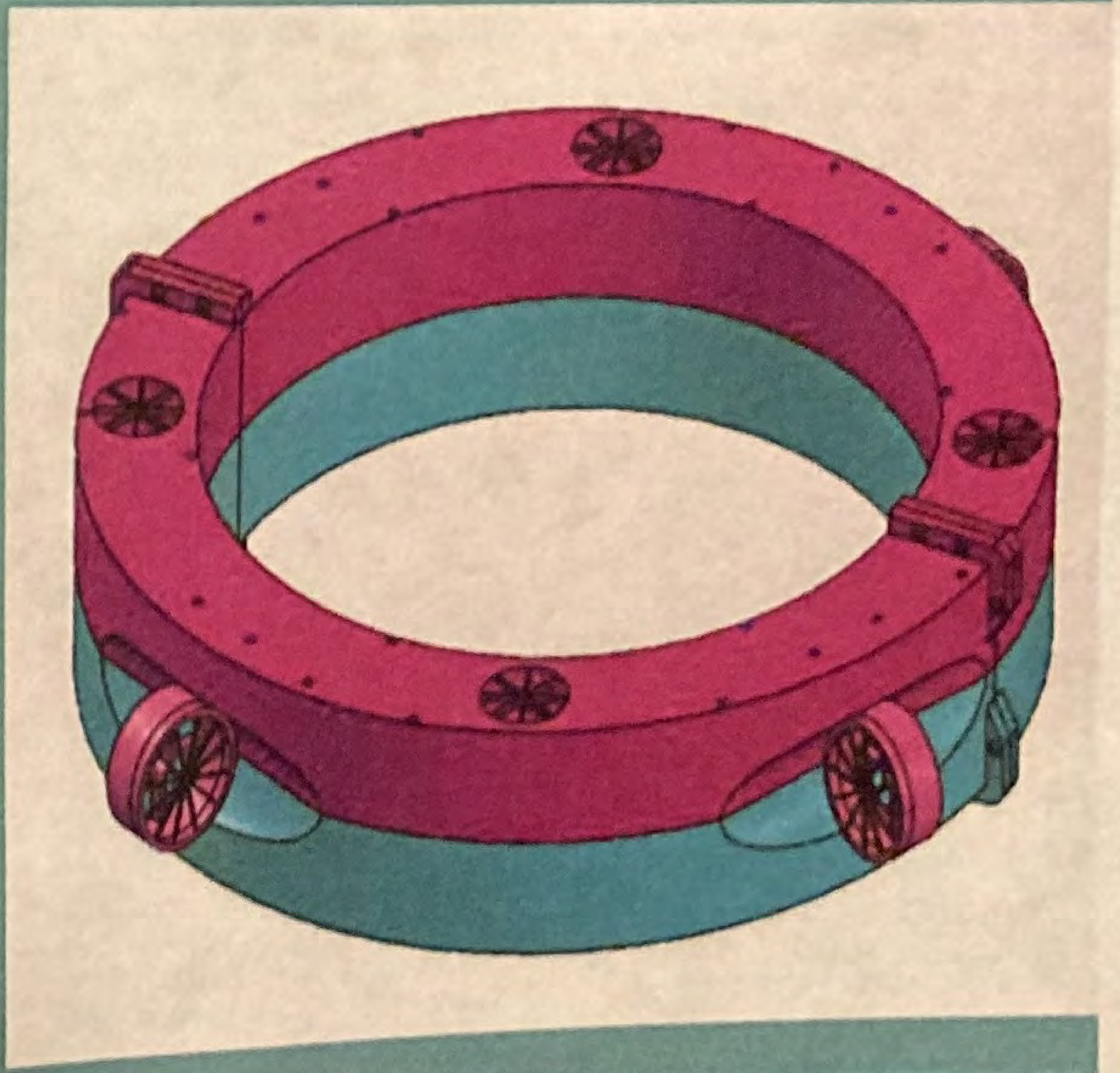
KWADROPUS PROPULSION BELT

ZACH LEHMAN

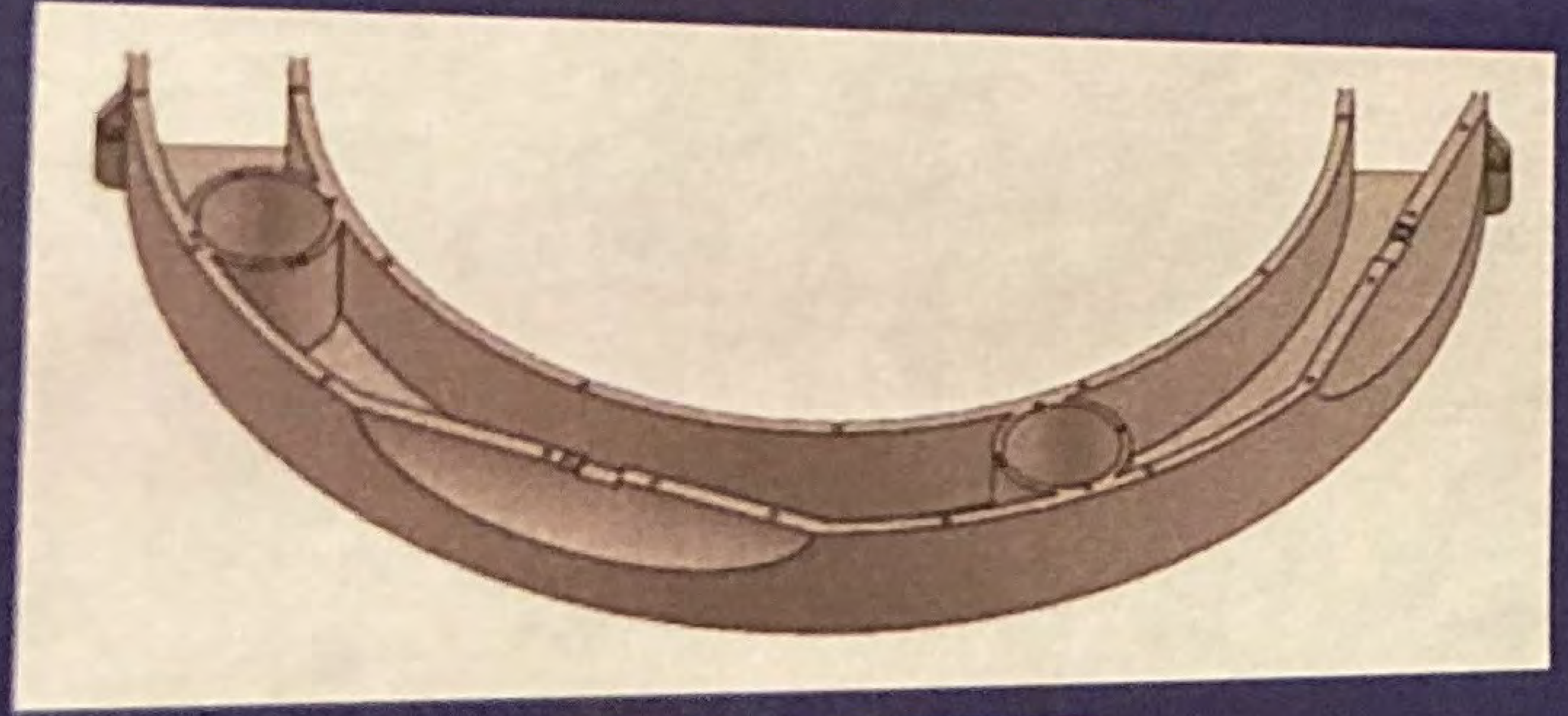
HUSAM ALBOUSH

KETTERING FAIRMONT HIGH SCHOOL

TEACHER: BRETT JENKINS



Inside Assembly

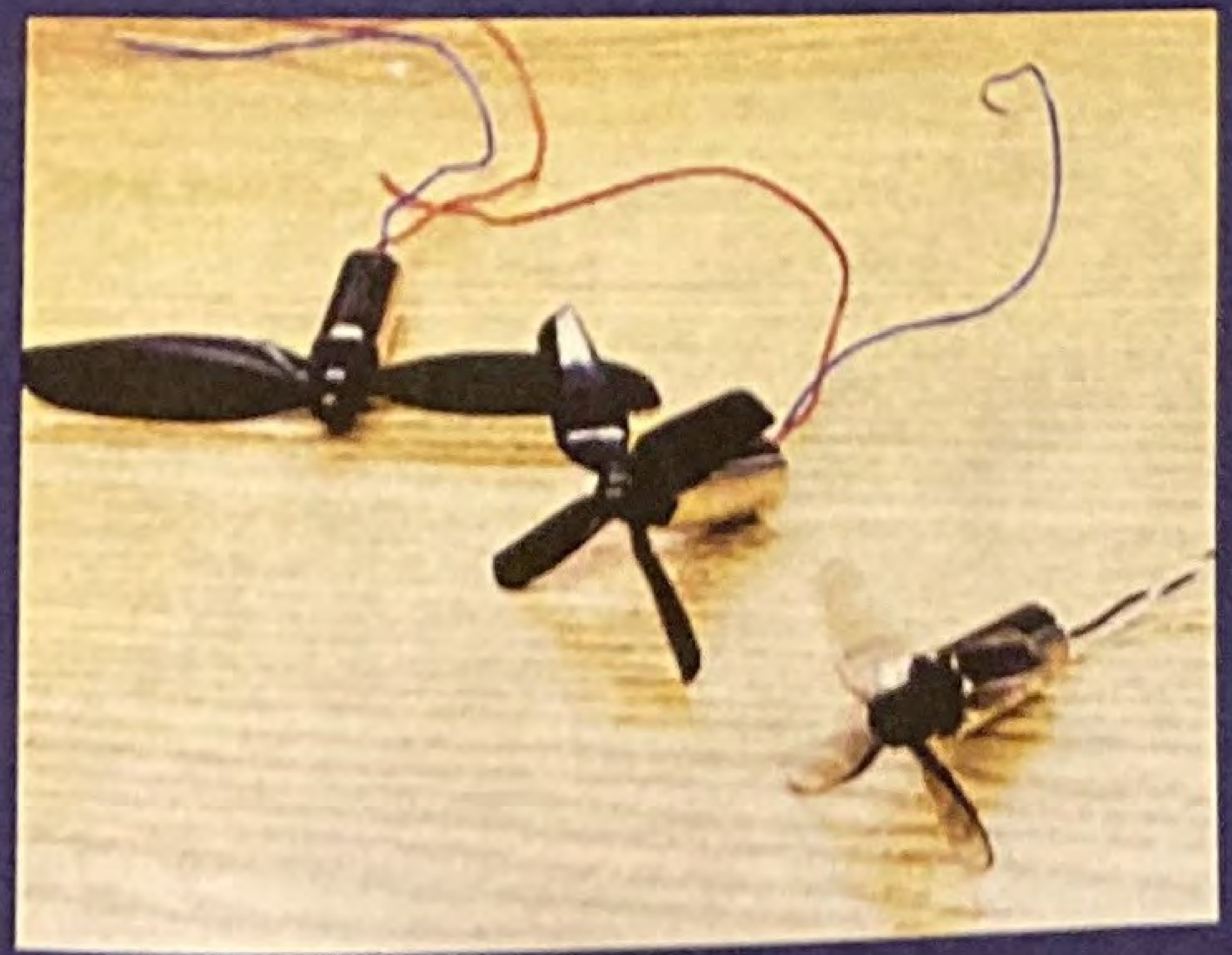


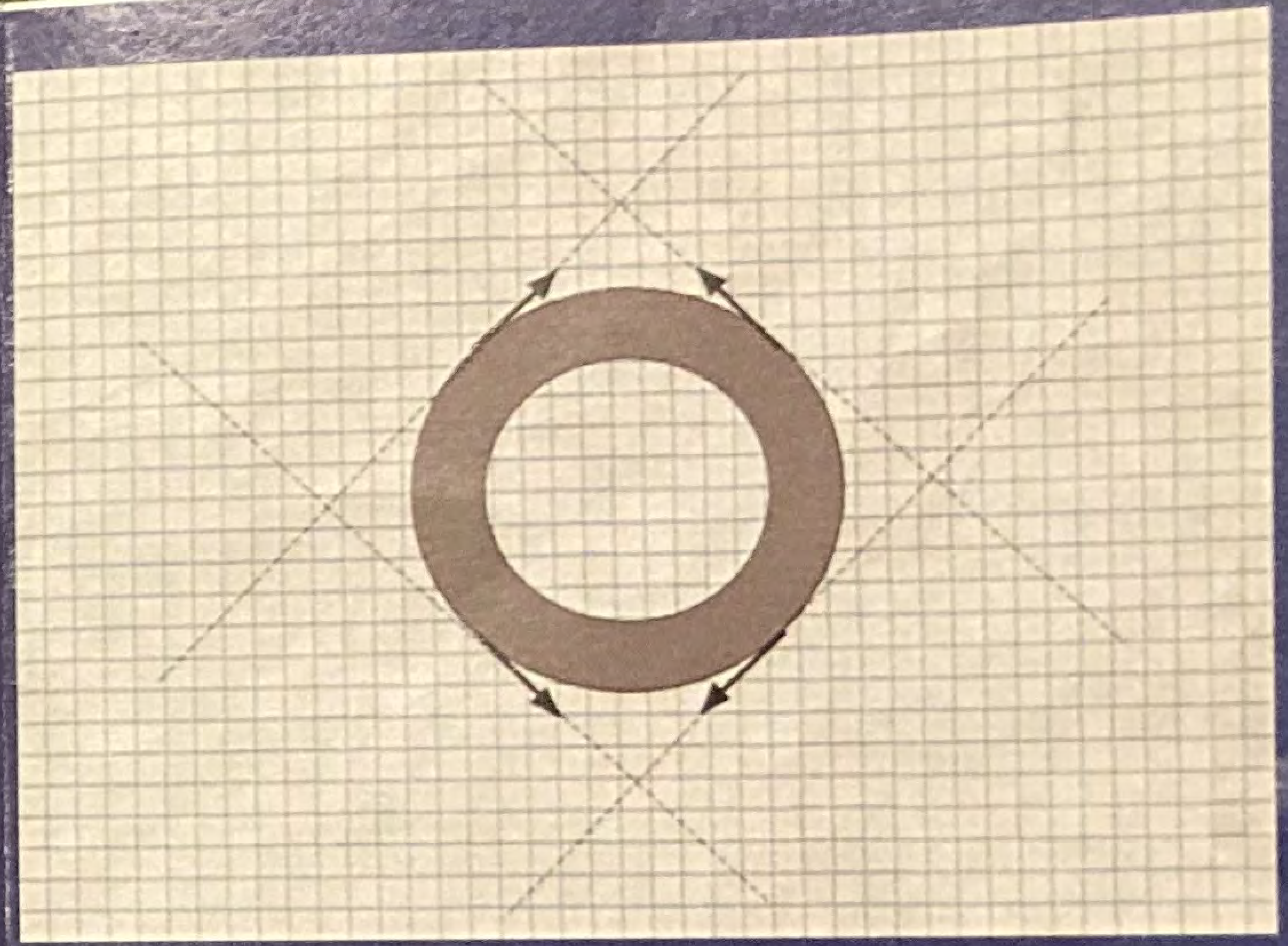
Bottom Half

TopHalf

Design

The latest prototype would be composed of two halves, secured by dowel pins and threaded bolts to ensure a tight fitment and easy accessibility. The bottom part includes fitted holes for the dowel pins and threaded holes for the bolts. The upper part easily aligns with the holes in the lower part, and hold the dowel pins. Cutouts included ensure maximum airflow to the fans with little to no obstruction. The two halve design minimizes manufacturing waste while maximizing the maintenance accessibility.





Movement

The Propulsion Belt is powered via four horizontal motors equipped with drone fans angled 90 degrees from each other. Additionally, it is powered by 4 vertically facing motors with the ability to reverse polarity for upwards and downwards motion. The propulsion belt design utilized force components to access full motion in the xyz-planes and has the ability to rotate clockwise or counterclockwise to mitigate any uncontrolled spins.