2022 Design and Prototype Finalists

Electromagnetic Boots

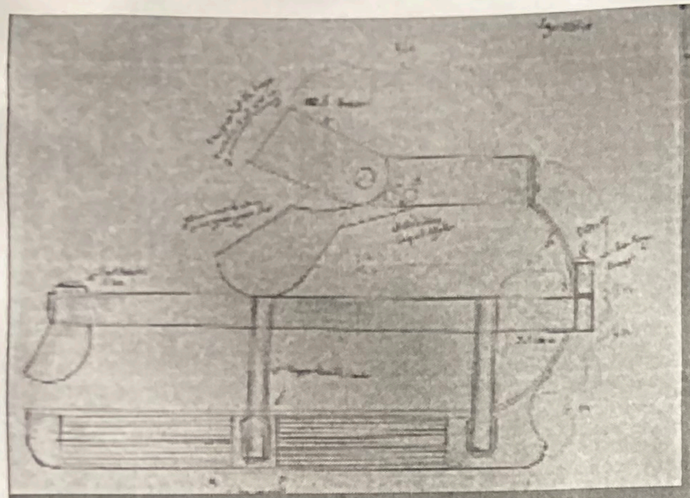
Students: Diego Molina
Teacher: David Laughlin
School: Bridgeland, TX

Students: Andrew Butsch, Sarah Winkler
Teacher: Michael Hayes
School: Theo, Texas

Students: Zoe Jones, Kofi Asare, Christian O'canna
Teacher: Nate Olsen
School: Warren Tech Central, Colorado

Students: Jack Weber, Maxwell Craig, Bennett Minahan Pomering
Teacher: Joel Bertelsen
School: Chatfield, Colorado

NASA
MISSION CONTR
HISTORIC LANDMARK
ORIGINALDESIGN
CURRENT /IMPROVED DESIGN
TYPES
MAGNETIC SHOE
RESEARCH
BRAINSTORM SOLUTION
3.
Develop a Testable Solution
DURACELL



INITIAL DESIGN

DEFINING THE PROBLEM

One of the largest problems of space travel is getting use to zero-g. Many astronauts at the climax of the space race used the outside of the ship, like "Alexei Leonov" of the soviet union, even going as far as using his life line to move around. From there we began using rails/ ladders to traverse the space station, eventually landing on the MMU short for Manned Maneuvering Unit. However we reached an obstacle, one of the stability on other worlds and possibly space during long distance travel. Not only having to achieve such goals but also having to adapt to the space crafts being created today, such as the "BFR". Thus the idea of being able to stick to the side of the spacecraft came up. Using the power of electro magnets to stick to the hull of the spacecraft, astronauts are given an easier and more efficient way of travel .

CONSTRAINTS

Building a magnetic shoe that can hold more than 20 pounds per foot and simple enough for astronauts to use.

MAGNETIC BOOTS

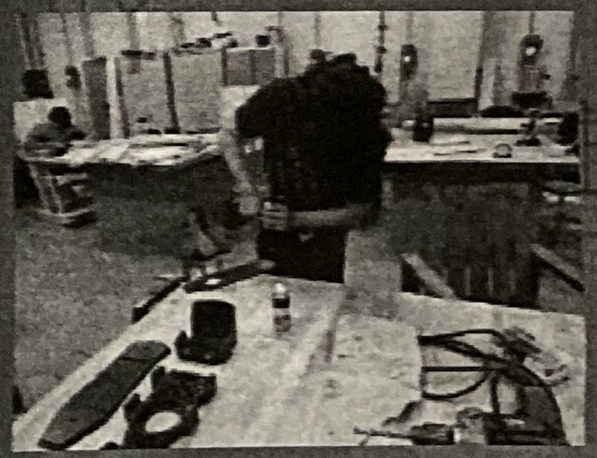
BY DIEGO MOLINA

HOW IT WORKS

First, I needed a base for the boot, so I traced out the perimeter of my shoe (since I didn't have access to a space suit). Next, I drew where the user would need the most support and how the on and off switch would work. My first design was complex and required a lot of things to align and work together every time. The movement of the ankle pivoting would send a signal to the arduino telling it that the sensor was set off. This causes the magnet to turn off as a result. This would cause the user to be able to step forward. While the motion is happening, the other foot stays planted and immovable until the foot in motion stops. From there the process can repeat, causing no risk to the user floating off into the void of nothingness(that being space). A similar concept to"Clic-it", a safety climbing mechanism where only one of the locks can be released at all times effectively preventing any deaths while using it. Keeping the same concept, I redesigned it to a much more effective and simpler mechanism, like drum bass pedals that use the natural action of the human ankle to pivot down and up. The same mechanism could be done by lifting the heel and pressing down with the back of the foot to turn the magnet on and off.

RESEARCH

When the idea was brought up, the same video popped in all my fellow magnetic boot engineers heads. Colinfurze 2014 DIY X-MEN MAGNETO walking upside down with magnetic shoes. Excuse the long title ... anyways back when this video dropped, I was intrigued by it and how he used electro magnets to stick to the ceiling of his shop / shed , but I didn't think much of it until now. Microwave magnets were off the table for me, but the concept was there. The next thing up was the shape of the boot using human shapes and inspiration from medieval armor. From this point on all the research was focused on what electromagnet I should use, the battery ,button, arduino(the necessary components to get the most out of the magnet).



CONTACTS

Teacher: David Laughlin
Personal: 832 888 8113
School:
Bridgeland High School
10707 Mason Rd, Cypress, TX 77433
(832) 349-7600

METAL BOOT

COMPONENTS

METAL : SHEET MATAL 11 GAGE

ELECTRICAL : WIRING, ARDUINO , INDUSTRIAL ELECTROMAGNET, DOOR HINGE , SOLID STATE RELAYS, BUTTON , AND BIKE BATTERY

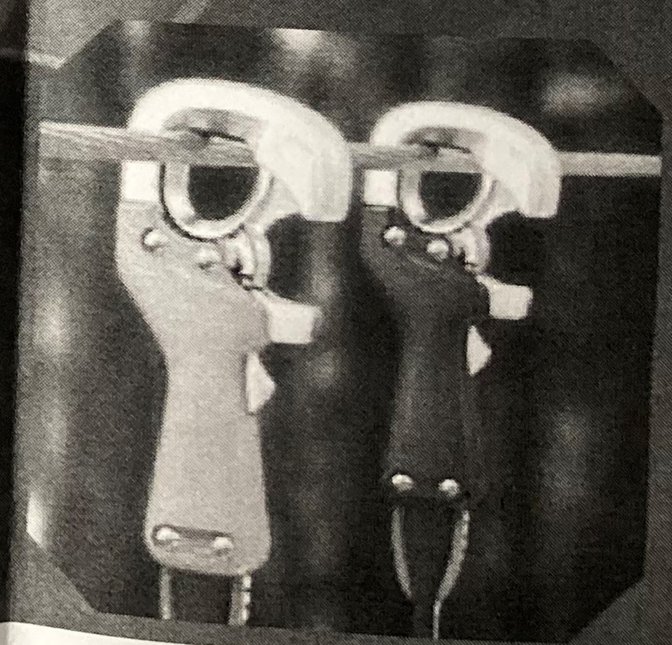
SCAN TO SEE THEM IN ACTION

HOW IT WORKS

The Metal boot works like armor around your foot keeping everything attached to your suit with ought affecting or negatively interacting with your suit. The shoe slides into place through the ankle of the metal boot. The two jaws of the metal boot rap around the side of your shoe to keep you from sliding around with additional support coming from the lip at the tip of the metal boot. Rods on either side lock in with a bolt lock keeping everything supported evenly. The arch of the back of the shoe gives the user space to stretch and fit into place while holding the most important mechanism of the entire device. The ankle holds a shoe like tongue that pivots to alert the Arduino of the users movement thus telling it to cut power to the magnet. Giving the user the ability to step forward. Once the distance sensor confirms that the metal boot has landed after a 1 second it will give power back the the magnet keeping the user stuck to the ground. During the entire process the other shoe will not be able to move no mater what the user does; preventing any and all possible accidents.

INSPIRATION FOR MECHANISM

Clic -it, is a safety component used in a "Adventure course" in Florida called Tree Umph. Used to keep the user safe at all times using a simple rule. If a clip is already locked onto a safety line the other lock will stay open until it is clicked in keeping the user fully attached. But if at any point the user decides to unlock one of them the other will not come off. Still the user can pull of one of them to attach them selves to the next course as long as one of the safety clips is on a line and locked. only being able to both be released once on an open safety line / a hook in this case. The same concept will be used on the metal boots to keep the user safe at all times (with changes to the design of Clic-it but still the same concept)



Andrew Butsch
Sarah Winkler
Theo
Mr. Hayes
Magnetic
Boots
Southern
Poles
Objective
Design magnetic boot prototype
Allow for astronauts to walk on spacecraft or magnetic materials
Problems
Astronauts need easy access to work on the ship
Allow for walking on asteroids
Criteria / constraints
Research
Hands free magnet capability
Motion studies to see how the human body walks
Electromagnets
Arduino
Bluetooth
MOSFET
Pressure Sensors
Motion Study
Design Propositions
Electromagnets on the bottom of the shoe
Pressure sensors control electromagnets
Arduino programmed controls
Bluetooth communication between boots
MOSFET transistor used as switch for high voltage circuits
Container to hold electronics
Materials
Brainstorm / ideas
Storyboard
Commercial Items
Southern Poles
Instruction Manual
Southern Poles
CODE
VISITOR
VISITOR

Current Design

(Things in light blue have changed from original design)

- Arduino controls electronics
- **Bluetooth, instead of infrared, talks between boots (So both are not off at same time and walking is easy)**
- **MOSFETS instead of H bridge**
- Breadboard
- Batteries
- Electromagnets
- Pressure sensors (Inside overshoe)
- **Ski boots with the front cut out to simulate *overshoes***

Southern Poles

By Andrew Butsch & Sarah Winkler

Hardware Tests				
Module testing on	**Hours spent**	**# of tests**	**Fails**	**Success**
Arduino UNO (clone)	97	84	78	6
Force Pressure sensors	16	8	6	2
NRF24L01+ (bluetooth)	61	97	85	12
MOSFET	46	47	44	3
Total	220	236	213	23

Software Tests				
Module software for	**Hours spent**	**# of tests**	**Fails**	**Success**
Arduino UNO (clone)	183	203	167	36
Force Pressure Sensors	32	23	17	6
NRF24L01+ (Bluetooth)	76	146	142	4
MOSFET	25	6	1	5
Total	316	378	327	51

Mechanical Engineering Tests				
Item Tested	**Hours spent**	**# of tests**	**Fails**	**Success**
3D Designs	168	28	2	26
3D Printer	14	5	3	2
Total	182	33	5	28

QR Code for Website

Southern Poles

MAGNETIC BOOTS

By Andrew Butsch & Sarah Winkler

Teacher: Mr. Hayes

School: Theo

The Original Design

In this design the parts were the battery, Arduino clone, h bridge, infrared sensors, electromagnets, permanent magnets (not shown), pressure sensors, motors for shield, and the shield itself. The Arduino controls all the other parts, using the infrared, the boots communicate as to allow for walking. When the pressure sensors sense that the person is lifting their foot, it releases the electromagnets. The permanent magnets have a shield to 'turn them off' when the person picks up that boot.

Innovations

- Walking motion activates/deactivates
- Programed Arduino
- Use Bluetooth to communicate between boots

Future Changes

- 3D print wire cases
- Add hard kill switch
- Omit breadboard
- Change from Arduino clone to Arduino

Summary

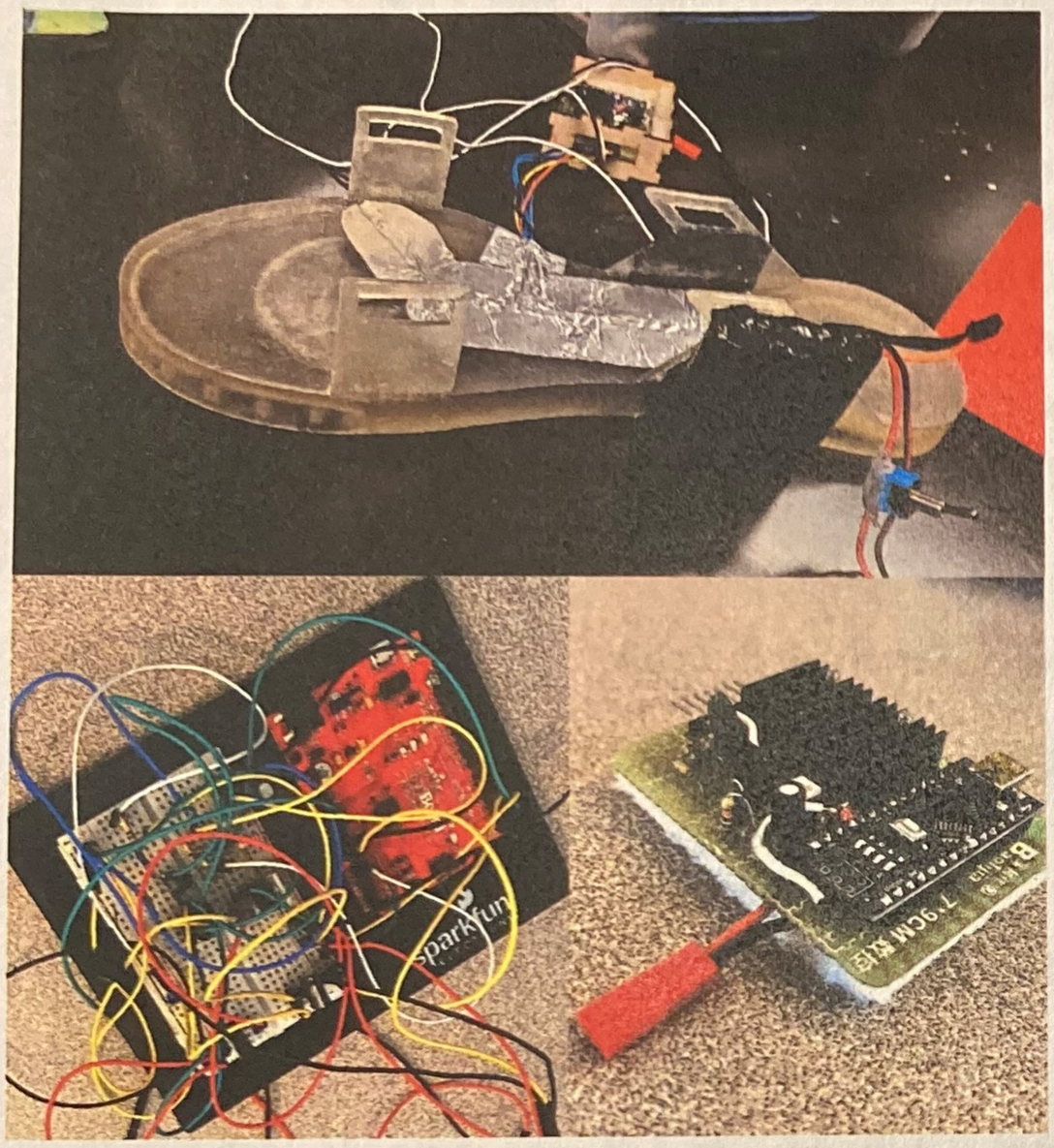
- Used ski boots with the front cut out to demonstrate overshoes
- Use Bluetooth to communicate between boots
- Plan on completely covering electronics
- Code with new Arduino (future development)

QR Code on Back

ISSUES WE'VE ENCOUNTERED
WASTING POWER
FINAL PROT
Magnetic Boots
NASA to G
Hard

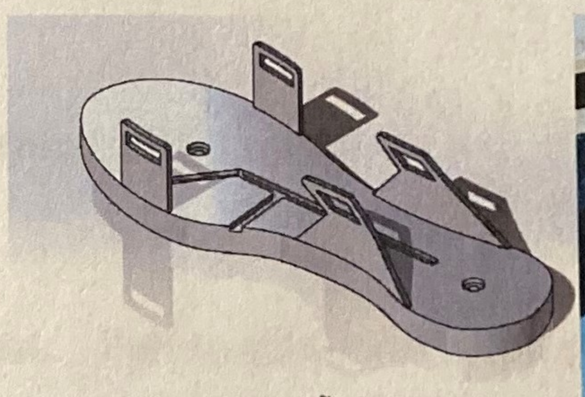
MAGNETIC SPACE BOOTS

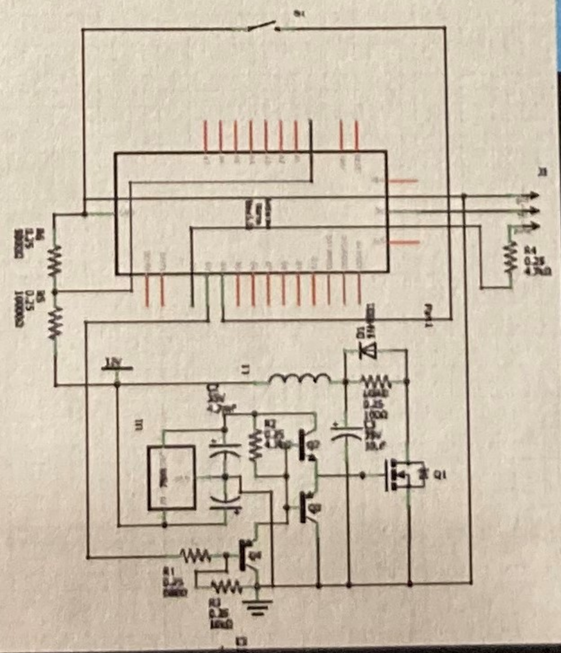
WARREN TECH
ZOE JONES, KOFI ASARE, CHRISTIAN O'CANNA

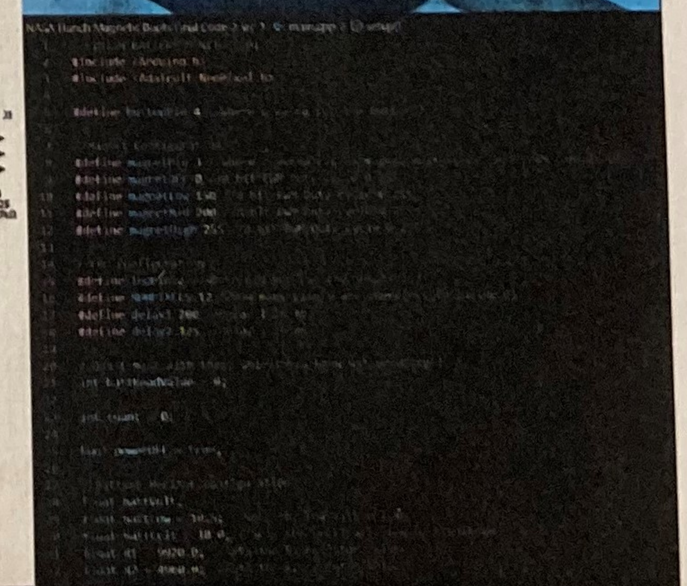


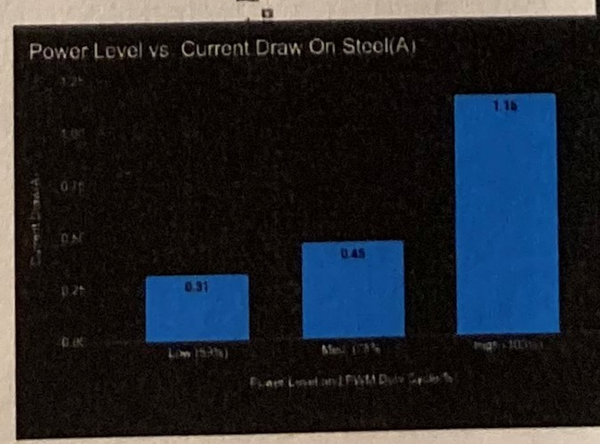
The main strength of our magnetic space boots include electromagnet control through pulse width modulation, LED lights/status indicators, and two 200N electromagnets. This design allows the user to have more precise control and awareness over the operation of their electromagnets. Whether you need to slide across the surface of a steel-hulled space shuttle or lock yourself in place, you'll be in complete control.

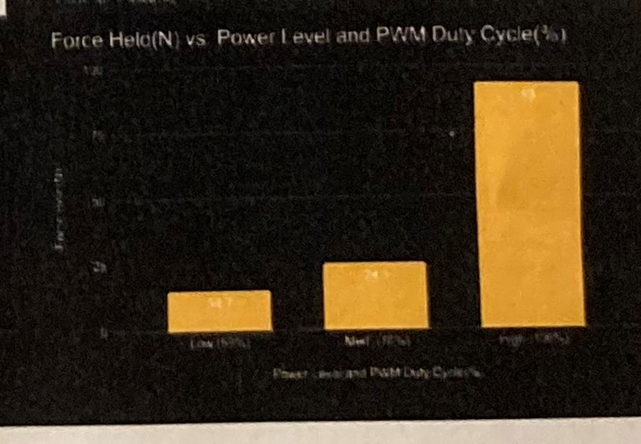
The unique set of strengths in this design is imperative so that the user is capable of the mobility necessary for every situation. Varying the strength of the magnets is a momentary push button, when pushed, the Arduino will change the current operation mode and indicate that through the LEDs. When pushed for longer periods of time the system will power on and off. All variables such as LED colors and magnet power levels can easily be changed in the code to meet each user's preferences.











EXIT
NASA
High school students United

Current Prototype-

Snowboard binding, two base plates

Front base plate serves for stability and an attachment point for the front magnet and motor

Back base plate holds second magnet, circuitry, and batteries

Two buttons, push top one to control magnets off/on

Bottom button rotates motor up and down

As motor rotates, the motor and its case will move, and the magnet attached to it comes up as well

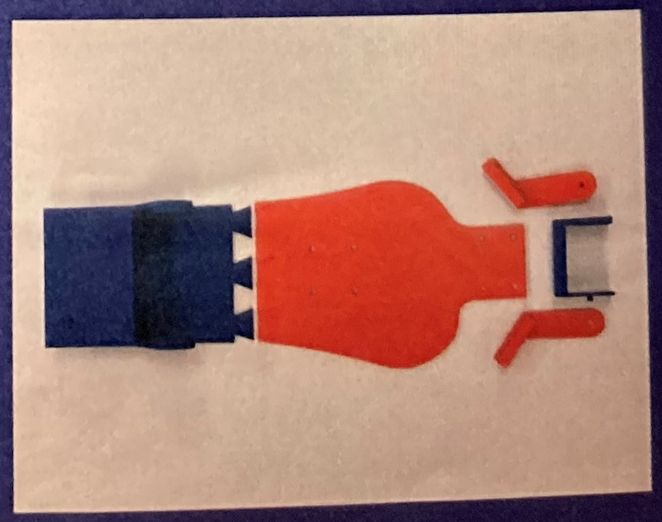
How to use-

Simple snowboard straps are used to secure boot

Have two switches from the hip that will control the electromagnets, its power, as well as the motor.

When top button is pressed the top button then it will turn on the magnets . Replace top button with dial so we can very strength

Pressing the bottom button will rotate the stepper motor attached to the front magnet 90 degrees forward



Future Improvements for FDR-

Add covering for back section to secure wires and batteries

Make switches easier to use for two boots, our design works good for one but not two

Intigrate dial to button attachment so we can vary the power of the magnets

Why Us?

Snowboard binding allows for fit to any boot, no need to change footwear

Rotation in the front magnet, allows the boots to work in any position

Strong boots/magnets lead to little malfunctions and reliability

Some aspects of the design are complex, but the ideas behind them aren't; NASA can simplify if needed

No extra parts needed besides batteries

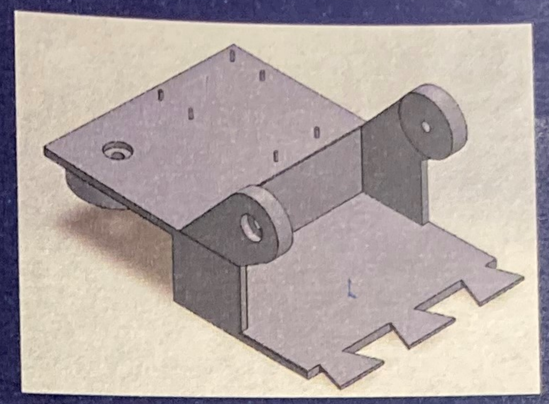
Different level of electricity to the magnets allow for ease of use

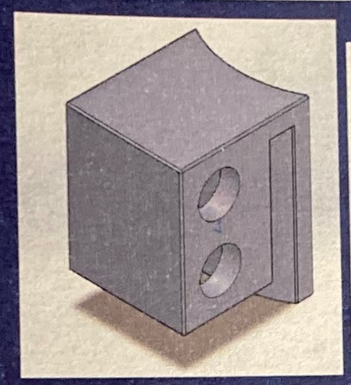
Boots are small and would not be challenging to take to space

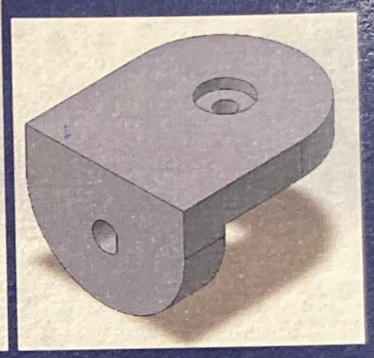
Simple buttons means no learning curve for use of the boots

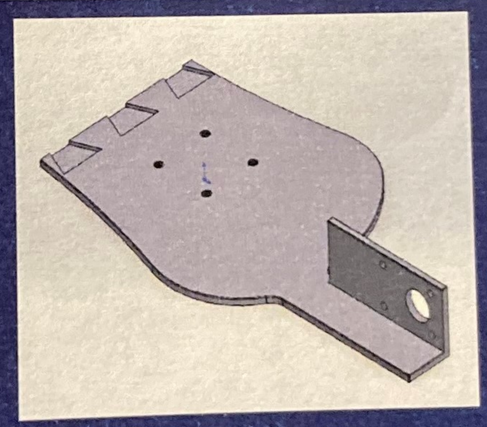
We understand our design and the capabilities it has, and if asked to, could reshape and edit certain areas of weakness to align closer with what NASA desires.

Solidworks Drawings-

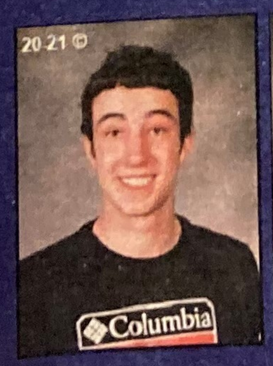


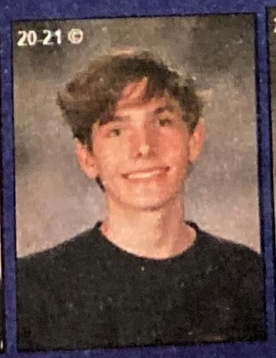


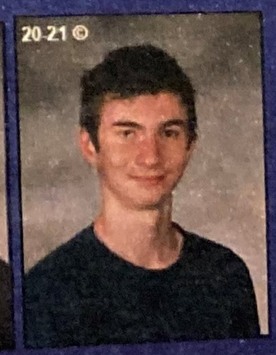




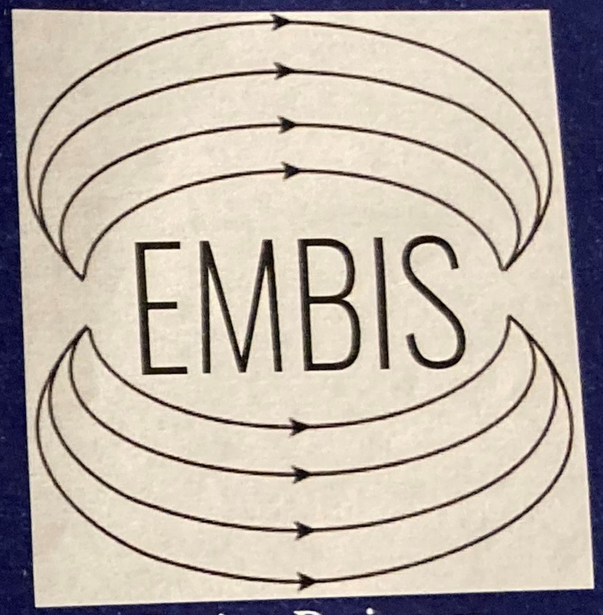
Us-







Electro-Magnetic Boots In Space



Project Designers

Jack Weber

Maxwell Craig

Bennett Minahan Pomering

School of Origin

Chatfield Senior High School

Littleton, CO

Year of Development

2021-2022