2022 Design and Prototype Finalists

Lunar Habitat Shoes

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School:	Cole Valley Christian, Idaho
Students: Teacher:	Lynelle Yadao-Ellazar, Anja Marie Henriques, Mikaella Casino Frederick Hermann
School:	Makua Lani Christian Academy, Hawaii
Students: Teacher:	Blake Iverson, Evan Herzog Barb Mcgregor Eric Anderson
School:	Billings Career Center, Montana
Students:	Akhil Asher, Eleana Yerre
Teacher:	Michael Hayes
School:	Bridge Builder Academy, Texas
Students:	Olivia Graves, Elliot Berger
Teacher:	Nate Olsen
School:	Warren Tech Central, Colorado
Students:	Jaynah Hasler, Joan Ake, Danial Olivas
Teacher:	Nate Olsen
School:	Warren Tech, Colorado
Students:	Elijah Sanchez
Teacher:	Pederson
School:	Lakewood, Colorado

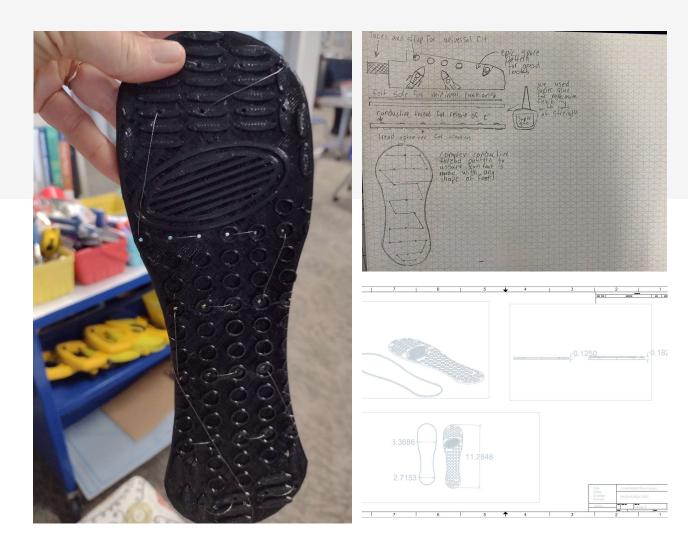
Lunaire

Shoe Specs

- We chose to create our sole out of TPU filament because of its flexibility.
- In the upper part of the shoe, we used materials such as felt and fabric to add structure and cover for the shoe.

Shoe Design

 We designed our sole with the help of AutoCAD and later scaled the shoe using CuraLulzbot, before printing it







Lunaire

Data

- T = Fp = 29.5N
- 15lb x 4.448N / 1lb = 66.72
- M = 29.5 / 66.72 = 0.442

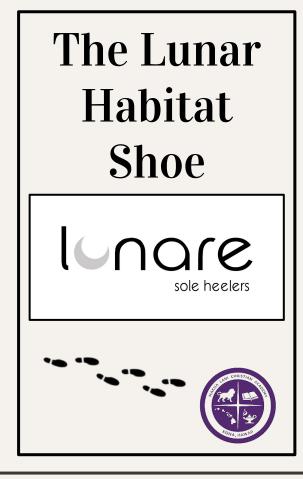
Electrostatic Discharge

- Our flooring is an ESD mat

- Inside the shoe and the sole is conductive thread to effectively discharge and help you drain electricity

- We hope to eliminate the risk of static build up by using this system.





Our Team:



[pictured left to right:] Lynelle Yadao-Ellazar, Anja Marie Henriques, Mikaella Casino





The Final Prototype

The Shoe:

- → Custom fitted
- → Upper Nomex
- → Infrared tested cooling vents
- → EVA foam padding for structure
- → Lunar trolley tested outsole
- → Compatible with modified ESD flooring



The Floor:



- → ESD flooring
- → Dissipates static charges
- → Rough side of flooring for traction and grip
- → Electrically conductive paint to prevent fraying
- → Paint modified with anti-skid additive

The Lunar Trolley:

- → Simulates lunar gravity
- → Allows evaluation of prototype shoe and floor
- → Conclusion: Firm sole for shock and rough floor for traction is preferred.



Test Results:

Anja Walking on Lunar Trolley with Final Prototype Shoe & Flooring



Anja Moonhopping on Lunar Trolley with Final Prototype Shoe & Flooring



Anja Moonhopping (towards Camera) on Lunar Trolley with Final Prototype Shoe & Flooring



- We designed a replacement for velcro/ laces that allows the shoe to be fastened seamlessly with low gravity in mind.
- The shoe sole is designed to have great traction while maintaining a simple profile for easy cleaning.
- The sole was designed in CAD and was 3D printed using V2 flexible resin. We recommend that the real deal is made from fluorosilicone and flexible PVC.
- Was created with a special design that would give the most comfort and traction, while being static dissipative, fireproof, and simple overall.



NASA HUNCH Lunar Shoes Billings Career center Mr. Anderson Blake Iverson, Evan Herzog Barb Mcgregor



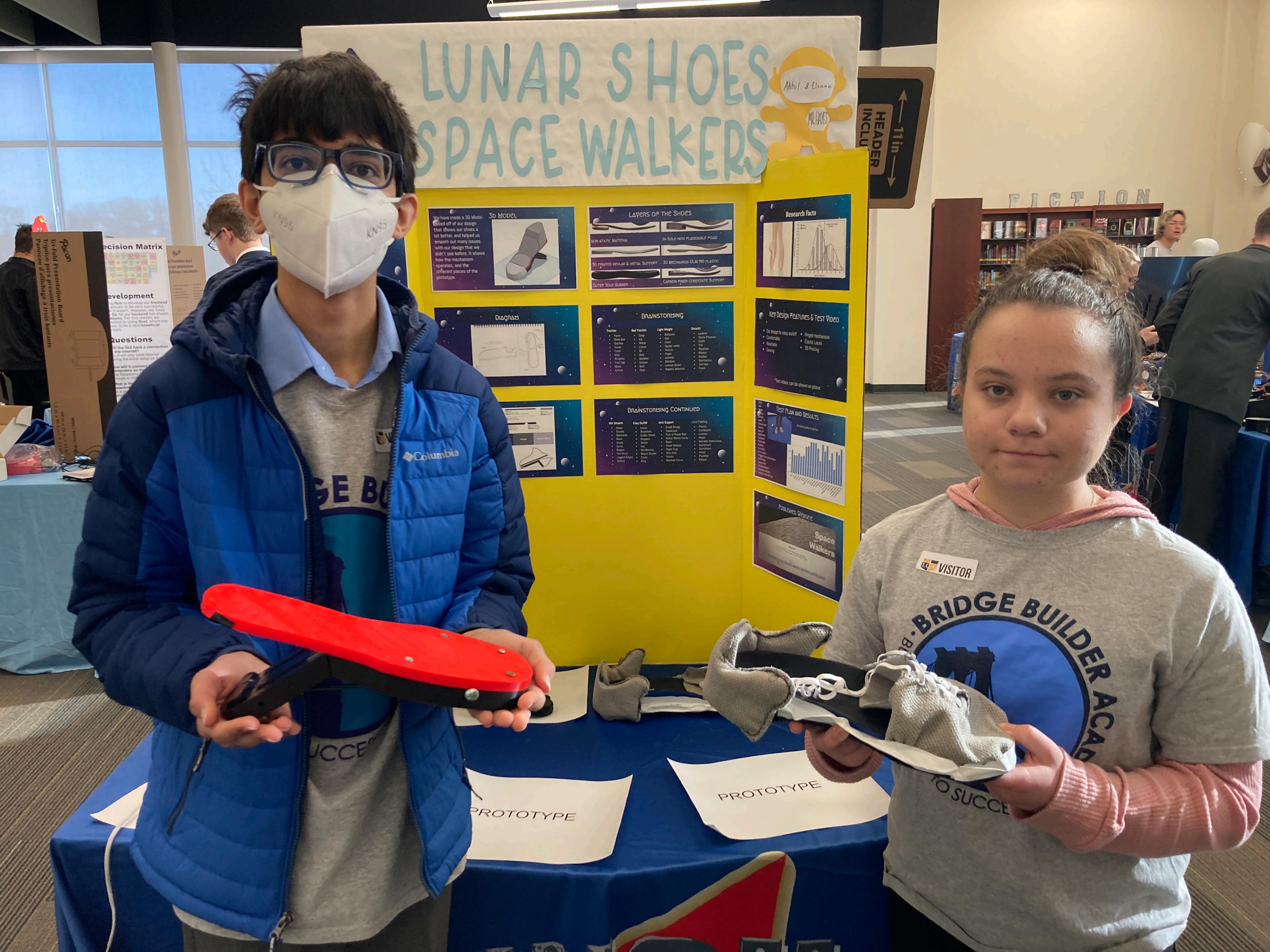
- The covering cloth for the foot is made out of nomex, kevlar, and elastic nomex.
- The straps that allow the shoe to perfectly form fit to the foot are made of an elastic nomex from Sentry FR® Nomex® FR Elastic.
- The shoe is designed to easily compact for storage.
- All materials to be used are lightweight
- Floor panels designed to have good friction, low static, fireproof, long lifespan, and easy to transport.

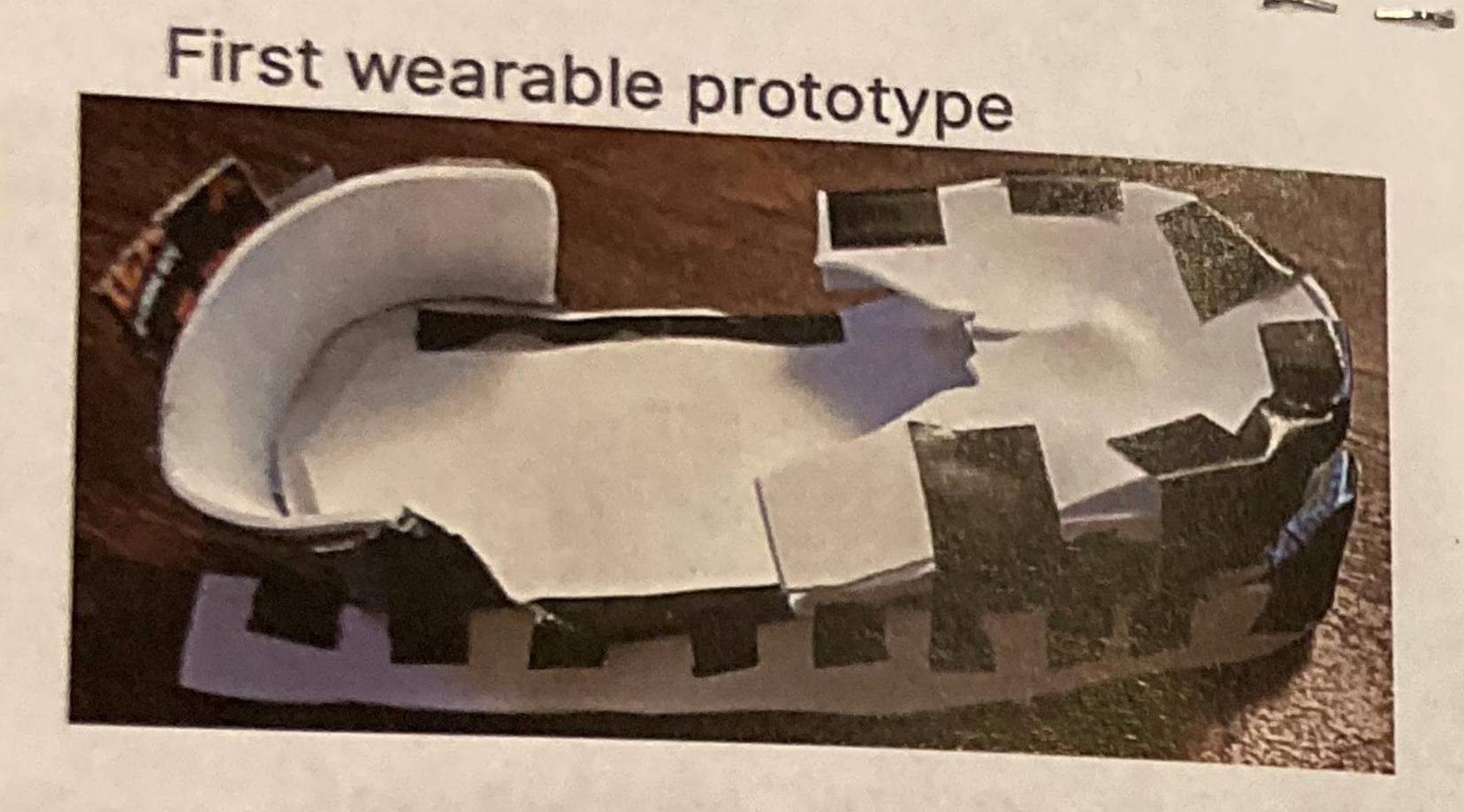
https://www.youtube.com/watch?v=79oztPuNBw8









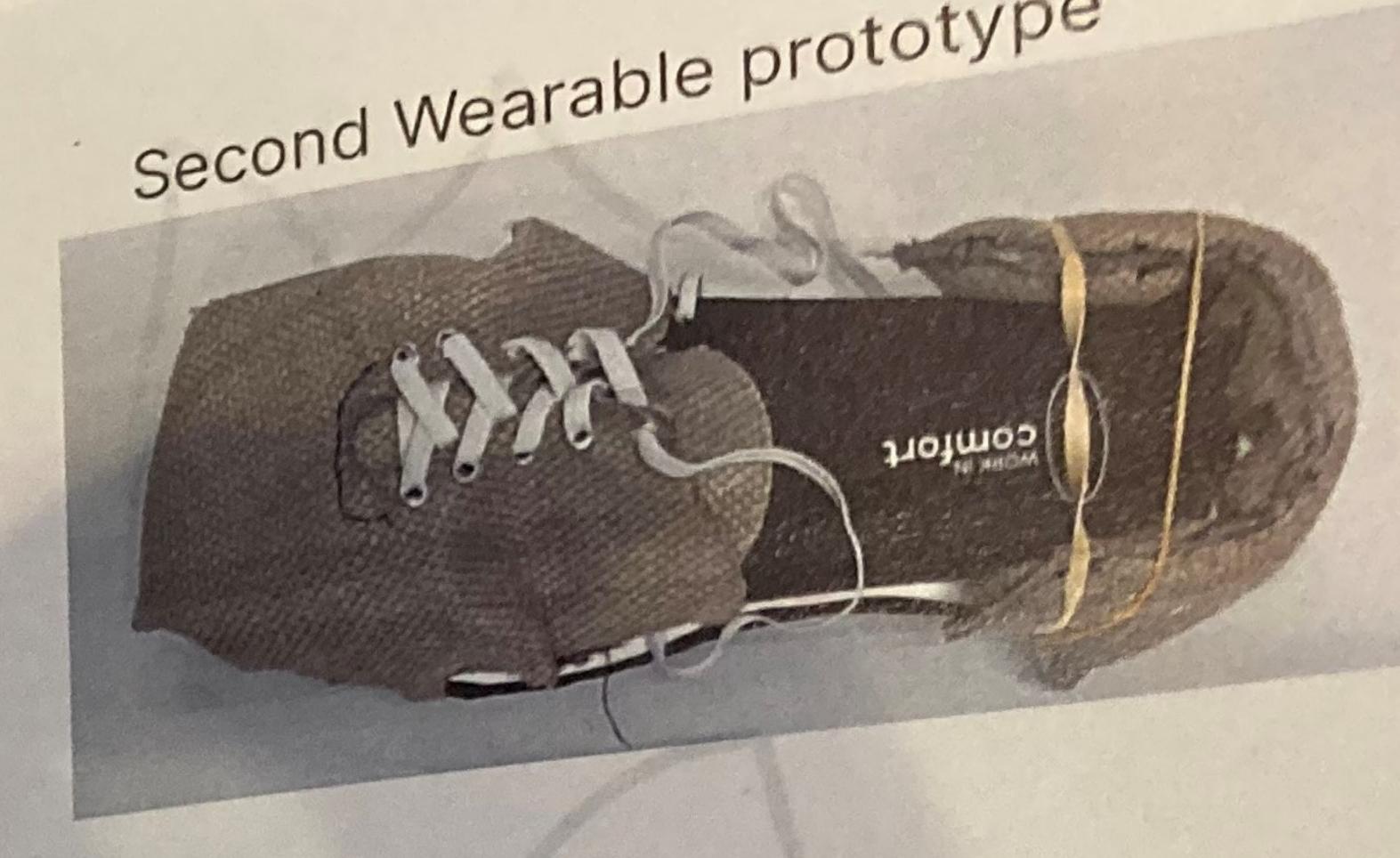


Over time, we have made four prototypes, including the latest. The first two were made for more of a test to see what ways were better to build it. The third was our presentation that accurately, but not fully, represented what out design would be like. The last two were fully functioning prototypes. Wen working on the prototypes, we found that some ways to build shoes are more efficient and reliable than others.

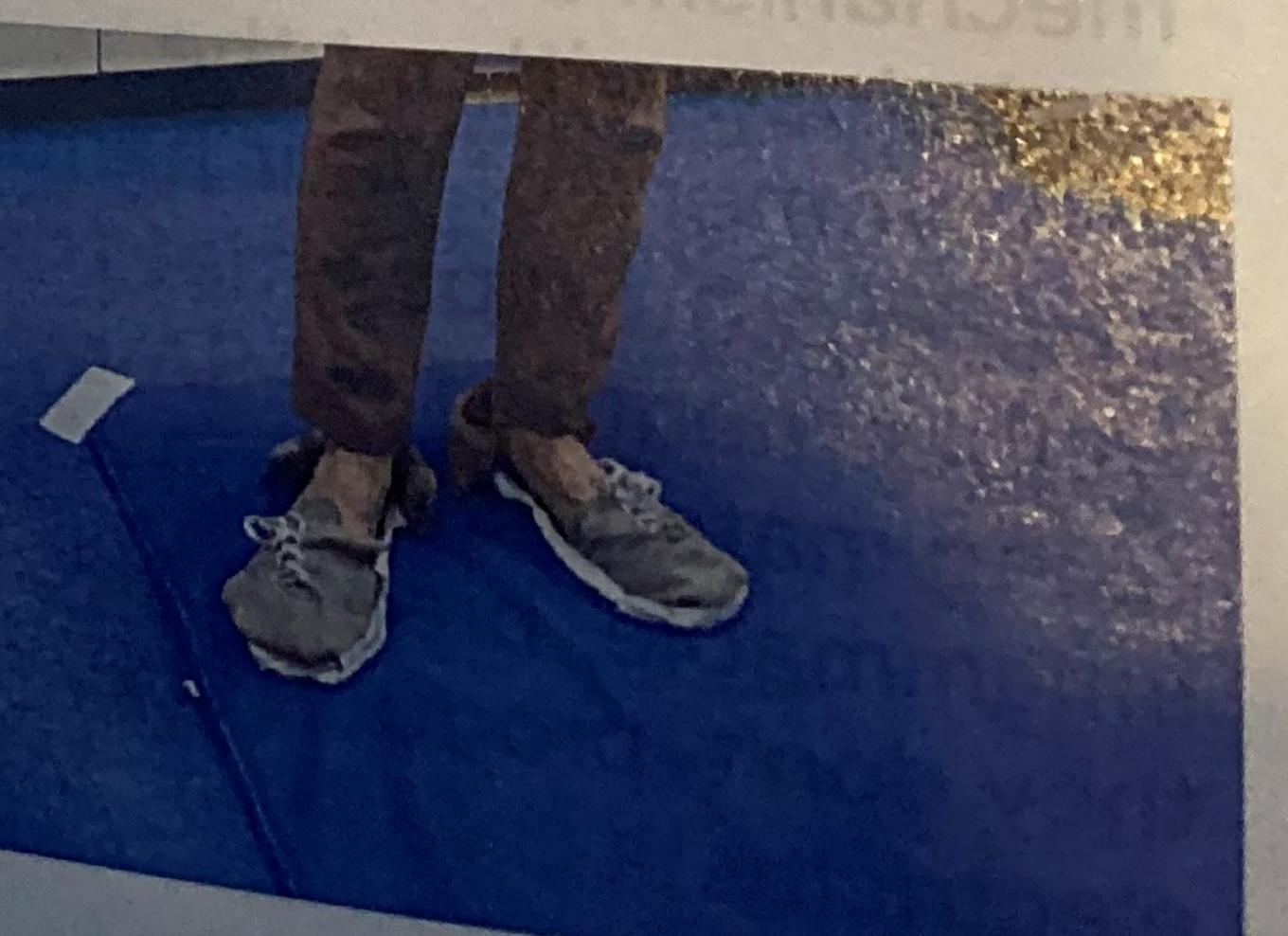
Third mechanical prototype

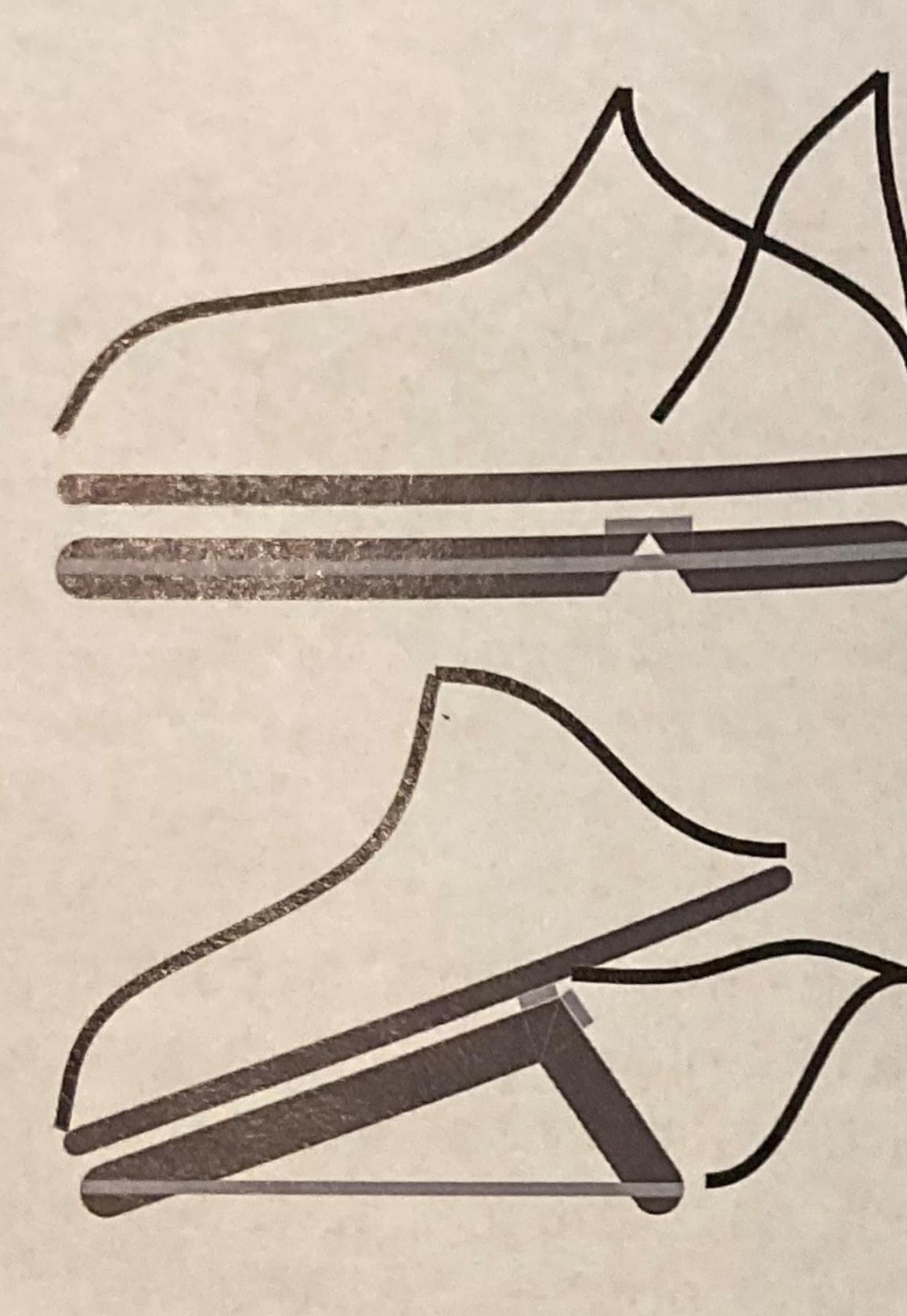


While making the third prototype, we constructed the design to represent the way our shoes would work. The mechanism would be incorporated into the inner sole of the shoe. It would have cushioning surrounding it and would be thinner. The mechanism is controlled by elastics in between the base, and inner sole of the shoe. It holds it up when not in use, and will help it remain on your foot.



After making the shoes, we and a group of individuals from our school tried on the shoes to make sure it held all the attributes. The testers tried on the shoes and gave feedback on what was good about the shoes, and what could be improved. These questions included if they were comfortable, if they looked okay, and other characteristics of the shoe.





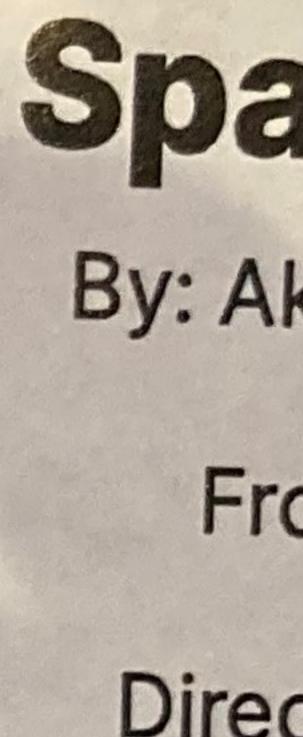
In working on the prototype, we discovered a multitude of materials and adhesives would be needed to make the final product. While making the shoes, we also designed and inserted a mechanism to operate the shoe. The mechanism allows it to open and close without the involvement of your hands. These prototypes met the requirements of NASA by using materials to make it inflammable, breathable, and they don't produce static electricity.

We have put together a website that shows what we have been working on, the progress that we've made, and the benefits of making mistakes for the end result.

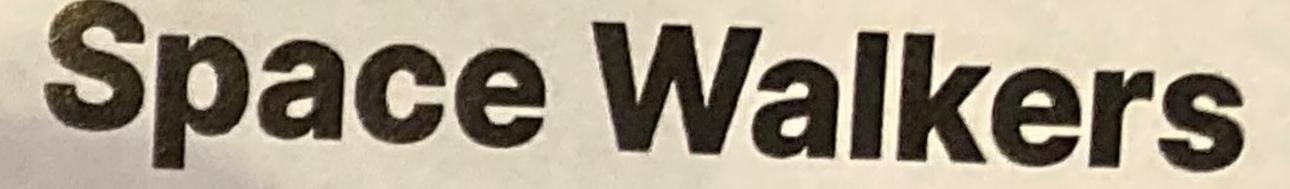
Our website address is: https://bba-nasa-hunch-spac e-walkers.netlify.app/

You can use it to observe our progress on our project, contact us, and ask questions. Our website also shows pictures of our progress throughout the time we've worked.





Our shoes will meet all of NASA's requirements to be worn in the Lunar Habitat with % the gravity of Earth.



By: Akhil Asher, and Eleana Yerre From: Bridge Builder Academy Directed by: Mr. Michael Hayes



Mr. Olsen Anna

POINT.

Why our Nano-Lab?

Our Nano-Lab has incredible promise to grow fungus in Zero-G to eventually be able to grow any plants in space. The Fungus Nano-Lab is a 10x10x20 be that can affordably grow and ingus in Zero-G.

Fungus Nano I Warren Tech Centra

Starting on the left. Baila Burnam, Tristan Burnham, Josh Kempe, Sophia Silis

chamber

STEM program Mr. Olsen

SDC-30 Temperature, Humidity, CO2 Sensor

Raspberry PIO

FOV Camera

water distribution mechanism

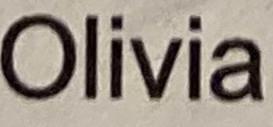


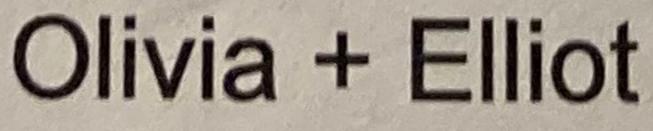
Our shoe will have a 3D printed sole made of silicone (can be replaced with other materials) with a honeycomb pattern by the toes and heel for traction. On the inside for comfort and arch support we will have a purple mattress cut to size. The material will be from a company called Milliken who will be supplying us with a stretchy, fire resistant, and anti-friction material. Also, a shock proof material as well which we can test on.



Lunar Shoes Warren Tech Mr. Olsen Olivia Graves + Elliot Berger

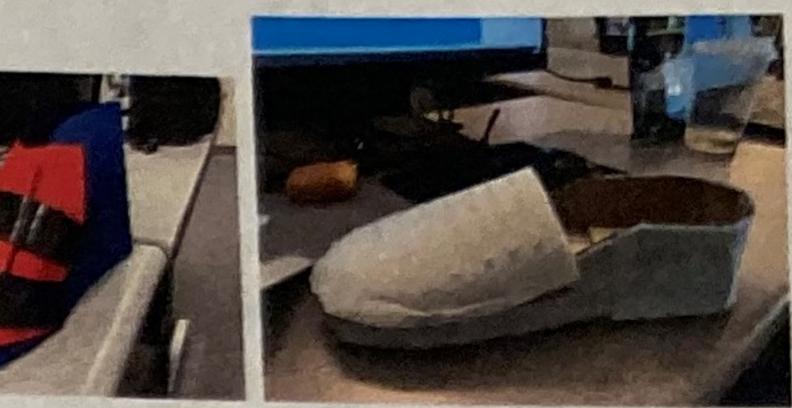








A couple reasons as to why ours would stand out is the comfort of the shoe on the inside and the elastic to make sure it bends with your foot when you walk. It will also have velcro on the top to make it easier to put on. The material we are using will be fire resistant and also lightweight so it isn't heavy on your foot. Also, we are working with another group so we will have the choice between a high top and a low top shoe. We are doing our best to make sure that our product is effective and comfortable, giving the astronauts a way to move around safely in space. Our shoes will be easy to wear and easy to walk in.



(Prototypes)

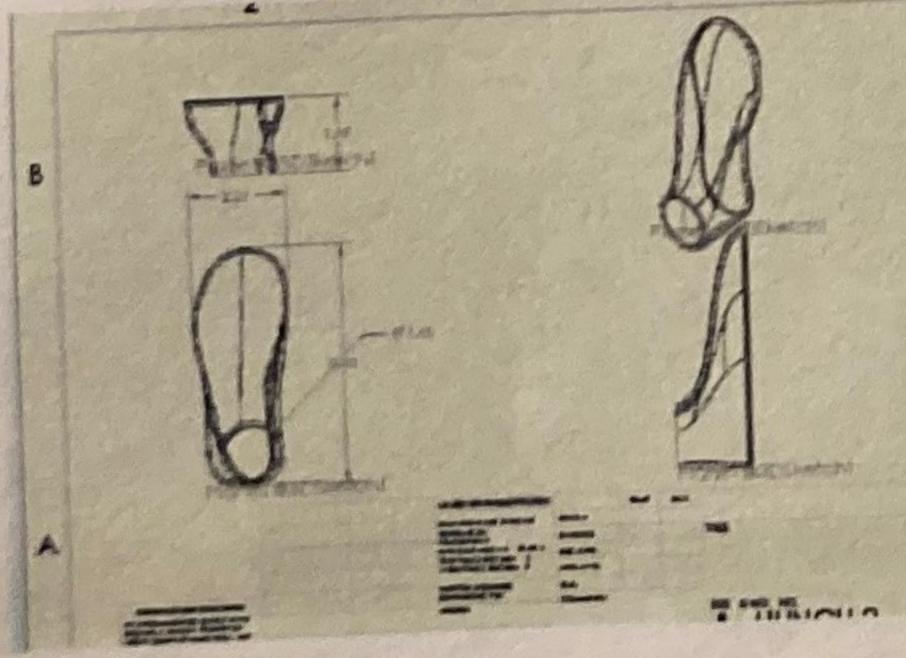
Warren Tech High School The highlights of Nathan Olsen our shoe: Jaynah Hasler, Joah Ake, Danial Olivas

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Our shoe is a lightweight, breathable, comfortable, and has compact design that will leave users astounded with all of its features. Some features include our flexible resin sole, Nomex, and our comfortable breathable foam. We also have improved the regular design of 5 an average shoe to make it able $\overline{\checkmark}$ to have both an arch support insert and the possibility of a vent to give it additional breathability.







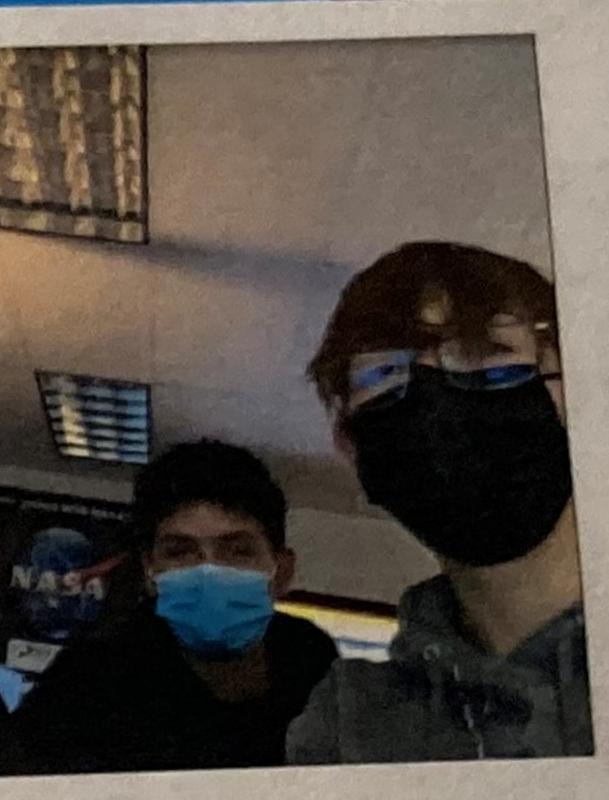
Final Shoe:

Final Floor:

nomex flap Itside 6X 0

cro





Materials:

Upholstery foam, 6 in. zipper, Nomex, 2 sided velcro, Flexible A80 resin, Black resin V4, polyester shoe top, and arch support shoe sole insert.

The Design Statement:

 The product that is needed is a shoe that astronauts in the lunar habitat can wear to provide comfort. protection, and aid in mobility. The shoe will be easy to put on with its slip-on and pull design. The shoe will have several components working together to prevent static buildup. The shoe will also be breathable and secure on the foot. The product will be made of anti-static/ fire resistant materials that are flexible and light. The product should protect the wearer from the cool environment and dangers of static electricity. We need to research insulations that can meet criteria. We also need to research the best layering patterns of the fabrics and other materials. We also plan to research the best fabrics that can be washed without water/ or dust resistance.

Criteria & Constraints:

terna a ser
• Criteria:
 Good traction
o Light weight
o Arch support
o Easy to take on an
o Can NOT create s
o insulation, but mit
o Less padding
o Must be flexible
o Easy to clean
o Durable, no break
o Nonflammable

· Constraints: o Dry environment Must avoid collection of space dust o No spikes o No sharp edges

o Must avoid static electricity generation

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LUNAR HABITAT SHOES Teacher:

Team Member: Elijah Sanchez

static electricity inimized sweaty feet

Testing & Analysis:

OUTSOLE- TESTING: The model was worn to test the stability of the shoe and to pinpoint main areas of the outsole that would need support. This was done by wearing the shoe and performing various tasks. Tasks such as jumping, pushing off from the front, walking. nanning up stains, and dancing. It was immediately brought to the wearer's attention that more support was needed under the shoe. This is because a lot of weight is put onto the inner and outer sides of the shoe. To solve this problem 4 differing size extrusions were added. The larger extrusions are 1.5 inches in diameter and the smaller are 0 75 inches in diameter. These sizers are results of dividing the next largest extrusion by 2. Such as the 3 inch diameter extrusions on the front being divided to get 1.5 inches and then that number divided to get 0.75 inches. The smallest extrusions were placed between the mid and and heel and the larger ones were placed between the mid met and mid arch.

FOOT INSERTION METHOD- TESTING: To test the functionality of the shoe's insertion mechanism, the wearer did as the mechanism asked. The wearer pulled on the small flap on the top of the foot and carefully inserted their foot. This test demonstrated the functionality and practicality of

the pull and step mechanism. The result was that the intended method of putting the shoe on was comfortable and easy. This result was concluded with the assistance of 5 individuals who put the shoe on and took it off.

OMFORTABILITY - TESTING To test the comfortability of the shoe wearing experience, 4 individuals put the shoe on and walked in it round the classroom and hallways. The shoe was reported to be comfortable for the most part except for one part. While walking the individuals stated that the shoe felt as if it were slipping off and that the back of their foot felt unsupported; causing an uncomfortable experience. I also observed the shoes' performance while they wore it and I noticed a disruption in the way the wearers walked. To fix this issue a horizontal strap of elastic was added to the back of the shoe to support the heel and keep the sole to the foot. This additional strap meant that there would be an additional step when putting on the shoe. This step would be pulling the strap back to maneuver the foot inside. To assist in this step a heet loop was added.

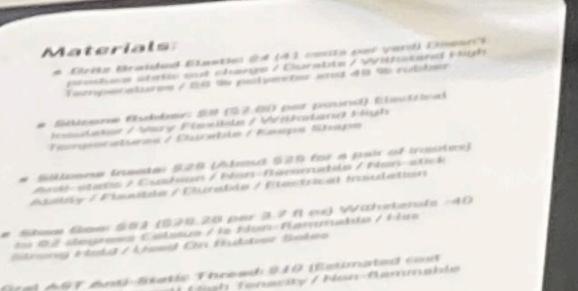
Lakewood Highschool Ashley Pederson

STATIC ELECTRICITY - TESTING: To test the conductivity of the Dritz braided elastic, a strip of the elastic was rubbed vigorously across carpet and bedding. Then the individual carrying out the test then touched various metal objects and fabrics. They touched light switches, door knobs, metal chairs, carpet, and other individuals. No sparks or The same test was carried out but instead the individual shocks were reported.

tied two straps of the elastic around their bare feet and walkedhild on the carpet for about 10 minutes. They then attempted to touch metal objects and other fabrics. No sparks or shocks were reported.











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Final Solution:

The shoe will have a silicon rubber outsole. The outsole will have a heel that is elevated by 15" and slopes to 0.5" at the top cap. The shoe's outsole will additionally have seven rounded extrusions on the bottom. The largest extrusions (3" Diameter) will be located below at the mid met, heel, and mid arch for support. Another two extrusions (1.5" Diameter) will be located between the three larger ones, but placed nearest to the side that faces inward. The last two extrusions (0.75" Diameter) will be located close to parallel to the other smaller extrusions, previously mentioned, on the opposite side. All extrusions have been added to aid in mobility and support. The four smallest extrusions among the seven were added after testing! Each of the three largest extrusions will have a cavity of space (2.7" Length / 0.27" Width / 0.07" Depth) that cuts through the center to avoid any possible suction and aid in flexibility. The seven extrusions are evenly spaced from each other and the edges of the sole.

Additionally, there will be a small toe cap made of silicone rubber as well. The insole will be a silicone insole which helps with comfort and adds a small amount of cushion and is also anti-stationon-flammable. The silicone insole also adds to the forming the shoe has on the foot. The shoe will also have five (Quantity adjusted to size during manufacturing) elastic straps that stretch over the top of the foot to secure the sole to the foot (four straps being 2 cm). The second strap over the foot will have a wider width of 2.5 cm. In order to prevent the shoe from sliding off and excessive separation of the heel and insole, the shoe will also have a strap (2 cm) in the back of the shoe. This strap will be horizontal, traveling around the heel. This horizontal strap will have a small loop (heel loop) that is 1 cm in width. It will be located in the middle of the strap so that the wearer can pull the strap out for foot insertion. There will also be an elastic strap traveling down the middle of all the other straps.on top of the foot, and will be connected to each. This strap will be 2.5 cm in width. The expased end of the middle strap should be pulled to loosen all straps for easy foot insertion. There will not be full coverage of the foot. All of the straps will be connected to each other with anti-static thread and the outsole will be connected to the rest of the shoe and insole with Shoe Goa. This design is accommodating to wearers already wearing socks!

Barelenergy: Name the groupouts on a scale of 3 for 6 scheric 5 is the highest. Plance add constants should the unspor barrows of the 1. Down the propert samply requirements and constraints? 1 1 1 1 2. Rate the creativity of the propert and the ideast within? 1 1 1 1 1 8 Down the propert and the students establish events and the encourage with at horse semiconstant? 1 1 1 1 1 A. Dones the project share professionation of the PowerPoint and your presentation? 1 1 1 1 1 Even the propert leave a section prototype?
 3 2 3 4 5 6. Is the fasting data clear and detailed with a performance demonstration showing the second of the design? 1 1 1 1 1 7. Enses the documentation allow for the replication of the durings industrig materials used?

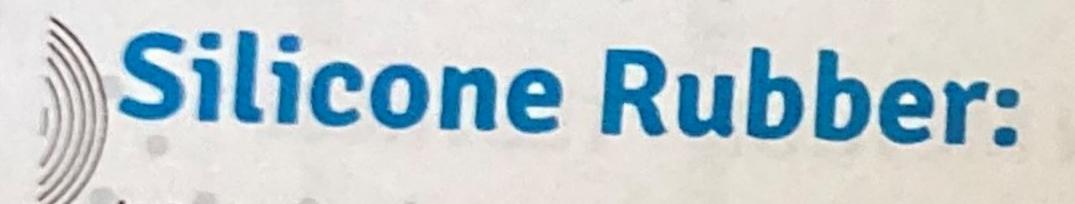
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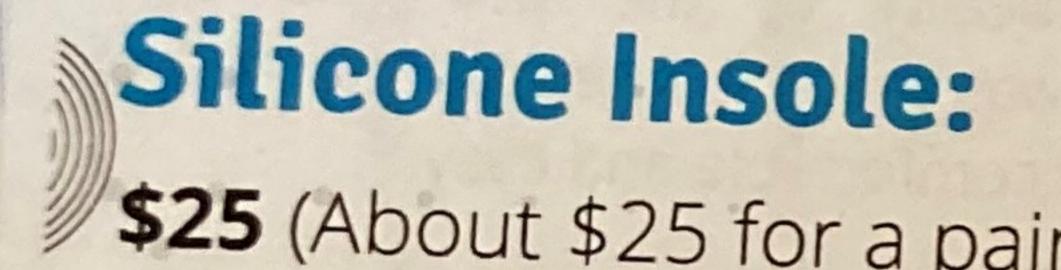
MATERIALS:

Dritz Braided Elastic:

\$4 (41 cents per yard) Doesn't produce static out charge / Durable / Withstand High Temperatures / 55 % polyester and 45 % rubber



\$9 (\$2.80 per pound) Electrical Insulator / Very Flexible / Withstand High Temperatures / Durable / Keeps Shape



\$25 (About \$25 for a pair of insoles) Antistatic / Cushion / Non-flammable / Nonstick Ability / Flexible / Durable / Electrical Insulation

Shoe Goo:

\$51 (\$25.28 per 3.7 fl oz) Withstands -40 to 82 degrees Celsius / Is Nonflammable / Has Strong Hold / Used On Rubber Soles

Gral AST Anti-Static Thread:

\$10 (Estimated cost for a 300 yard spool) High Tenacity / Non-flammable / Anti Static

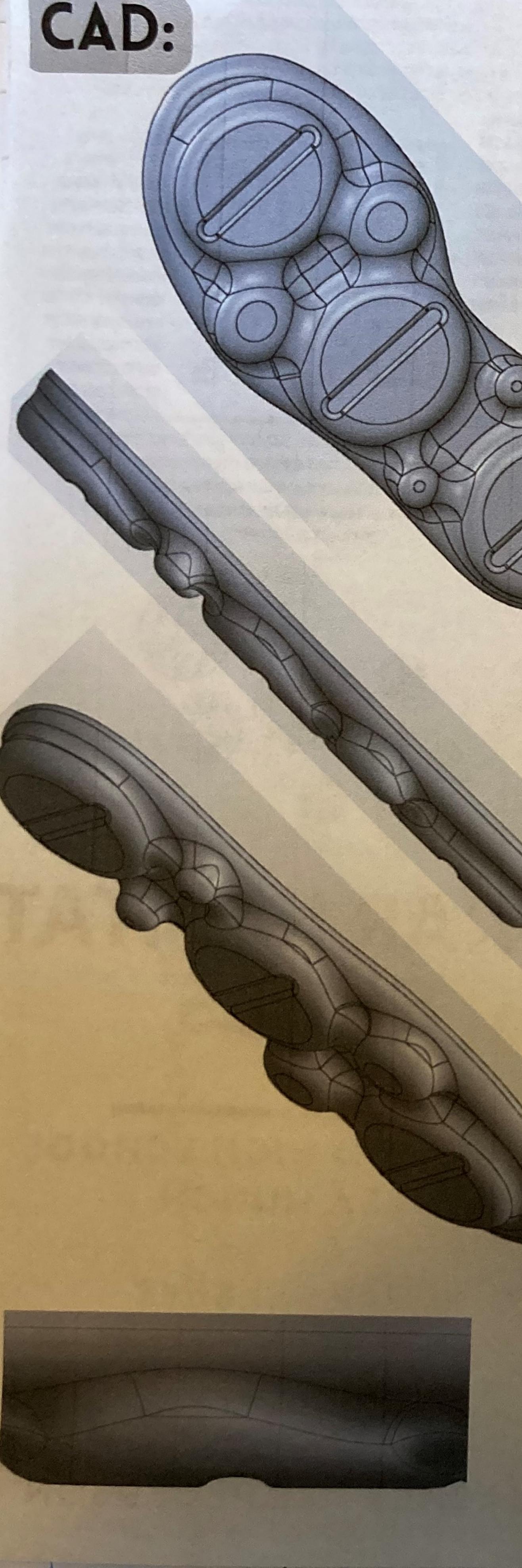
Vinyl Flooring Sheets: \$2 (Per square foot) Anti-static / Fire

Retardant / Easy To Clean / Light









FINAL SOLUTION:

The shoe will have a silicon rubber outsole that will have seven rounded extrusions on the bottom. Three having a (3" Diameter) / Two having a (1.5" Diameter) / Two having a (0.75" Diameter). The three largest extrusions will have a cavity of space (2.7" Length / 0.27" Width / 0.07" Depth). The insole will be a silicone insole. Small toe cap made of silicone rubber as well.

The shoe will also have five (Quantity adjusted to size during manufacturing) braided elastic straps that stretch over the top of the foot. There will also be a braided elastic strap traveling down the middle of all the other five straps to connect them. There will be a sixth strap on the back of the shoe to secure the foot traveling around the heel. There will additionally be a heel loop. The exposed end of the middle strap and heel loop should be pulled to loosen all straps for easy foot insertion. There will not be full coverage of the foot. All of the straps will be connected to each other with anti-static thread and the outsole will be connected to the rest of the shoe and insole with Shoe Goo. This design is accommodating to wearers already wearing socks! A flooring that works well with this shoe model is vinyl flooring sheets. They are easy to install and remove and are easy to clean. They are also anti-static and when compared to other flooring materials; fire retardant.

TESTING: Outsole - testing:

The prototype was worn to test the stability of the shoe and to pinpoint main areas of the outsole that would need support. This was done by wearing the shoe and performing various tasks. More support was needed under the shoe. This is because a lot of weight is put onto the inner and outer sides of the shoe. To solve this problem 4 differing size extrusions were added to the bottom of the sole.

FOOT INSERTION METHOD - TESTING:

To test the functionality of the shoe's insertion mechanism, the wearer did as the mechanism asked. The wearer pulled on the small flap on the top of the foot and carefully inserted their foot. This test demonstrated the functionality and practicality of the pull and step mechanism. The result was that the intended method of putting the shoe on was comfortable and easy.

COMFORT - TESTING:

To test the comfortability of the shoe wearing experience individuals put the shoe on and walked in it round the classroom/hallways. While walking the individuals stated that the shoe felt as if it were slipping off and that the back of their foot felt unsupported. To fix this issue a horizontal strap of elastic was added to the back of the shoe to support the heel and keep the sole to the foot. This additional strap meant that there would be an additional step when putting on the shoe. This step would be pulling the strap back to maneuver the foot inside. To assist in this step a heel loop was added.

STATIC ELECTRICITY - TESTING:

To test the conductivity of the Dritz braided elastic, a strip of the elastic was rubbed vigorously across carpet and bedding. Then the individual carrying out the test touched various metal objects and fabrics. No sparks or shocks were reported.

The same test was carried out but instead the individual tied two straps of the elastic around their bare feet and walked/slid on the carpet for about 10 minutes. They then attempted to touch metal objects and other fabrics. No sparks or shocks were reported.

COLK: \$10

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