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.

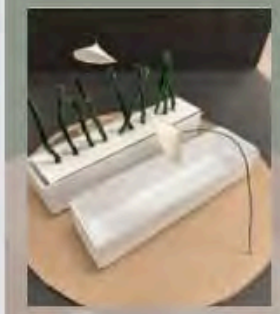
Each Mentor helped choose potential finalists for their area and were then compared with the same type of projects across the country. Teams that were selected to be finalists had very tough competition and it was very difficult to down select. Although everyone wants to be a finalist it isn't possible 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.

Preliminary prototype

For our preliminary prototype we used a clear bowl to represent our dome and glued a cut up paper towel roll as are entrances that lead to the inside of the dome. For are planters we cut foam board into boxes with the tops removable to show the drawings on the insides that show the hydroponics that will filter and circulate the water to help are bamboo grow more efficiently.To represent are bamboo we used pipe cleaners painted green and stuck them into the top part of sre planter



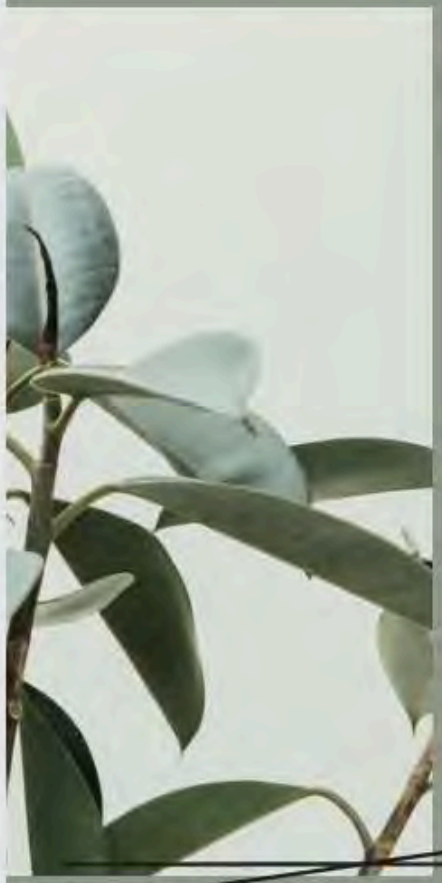
"

The more bamboo the better!

DATA

1. our first prototype did not show how our green house would work
2. Our second prototype was a bigger model of are planter showing how the pluming system would work
3. Our third prototype shows more int dept on are storage our slanted floor and the layout of the green house.

Final prototype



About our project!

The main goal on are project is to grow strong bamboo in space. Bamboo is the best option because it can get rid of CO2 and be used for building. The requirements for the area for the bamboo is it has to be in a 2' by 2' space and can fit on the table. The green house must have grow beds, lighting, plumbing, and a ,mixture of air from other places, with walkways and work areas.

Designers

Our Project.

Let's Connect

Julia Bunnell
11th grade, 3 year Varsity softball player

Kiersten Wigle
10th grade, 3rd year soccer player

Victoria Wolfe
10th grade, dual enrollment, JROTC

Seth Wright
10th grade, dual enrollment

BY: Julia Bunnell , Kiersten Wigle , Victoria Wolfe, Seth Wright

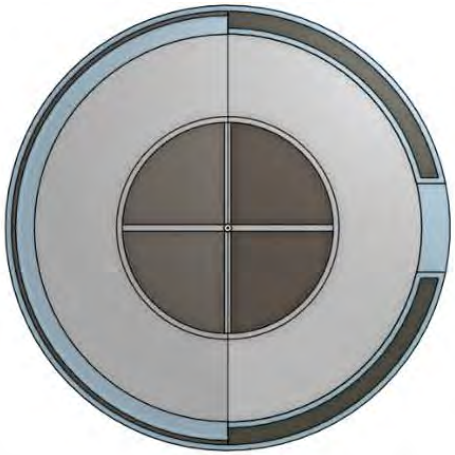
5th Lunar Bamboo Greenhouse

Bamboo Greenhouse

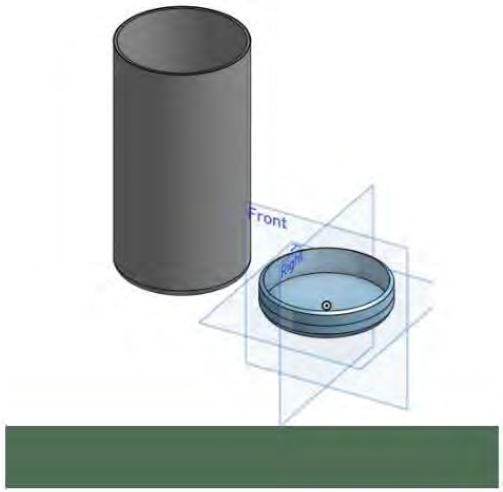
Our Bamboo

We grew three samples of Dwarf Fern leaf Bamboo one in potting soil and two in mixtures of garnet abrasive which acted as our lunar dirt. One pot was only garnet abrasive and the other was mixed with fertilizer.
We surveyed their growth over the span of three months, providing water and artificial light to help them grow.

Our layout optimizes space with a central area for growing bamboo and smaller grow beds around the exterior for young bamboo plants and bell pepper plants



We also made modifications to our design such as the inclusion of bell pepper plants and the use of bamboo rhizomes instead of seeds. We've also worked to design a capsule that uses moss to keep bamboo rhizomes damp but not molded throughout transport.



Our team with our bamboo plants

Maile Seymour,
Jackson Larue, Toby Powers

Scan to learn more about our design process

BAMBOOM GROWTH INFORMATION

For our water sensor we a moisture sensor hooked up to an Arduino board with a water pump

For growing the Bamboo we are deciding to do a mix of moon regolith and soil. We have found this to be the best way to grow it. 1 Part Moon Regolith to 1 Part Soil.

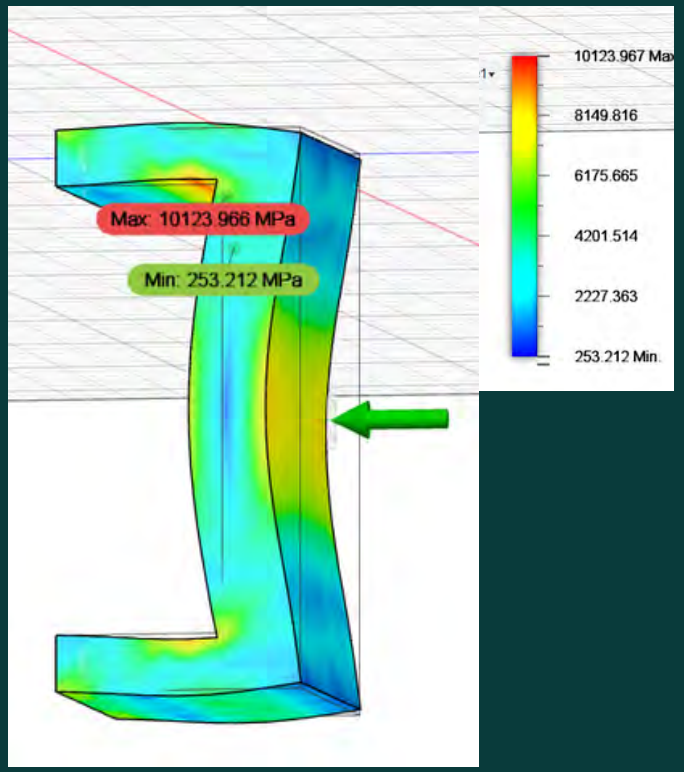
Bam boo boys

We have figured out that the best species of bamboo to bring to the moon is Dragons Head Bamboo. As it has the capability of being used for construction, food and CO2 removal.

Scaling - 3:40 inches

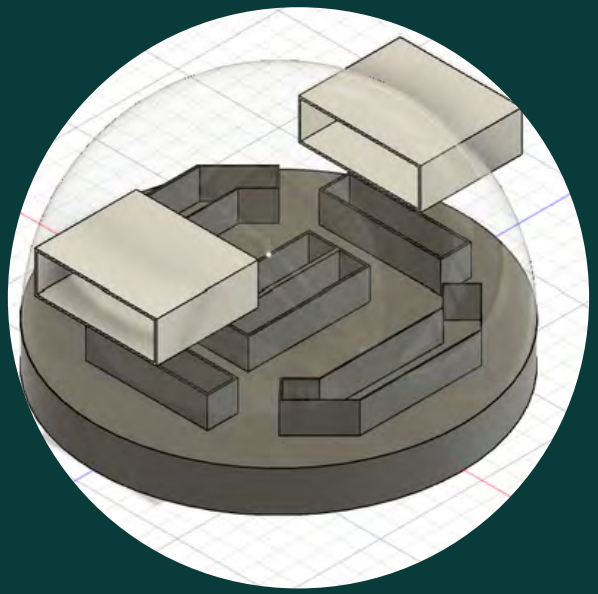
For the fans we have 4 fans hooked up to our Arduino board

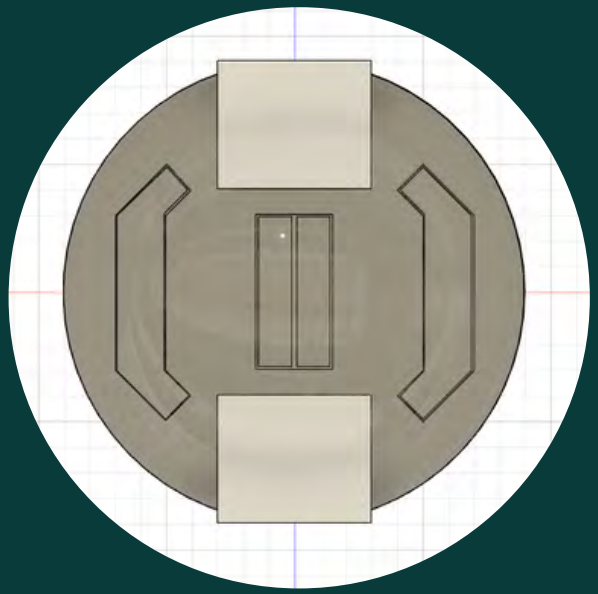
Materials



For the planter boxes we want to use Kevlar. Which has a reticence of 525,000 PSI. Bamboo presses at a rate of 28,000 PSI. The bamboo's force is 18.5% of what Kevlar can handle.

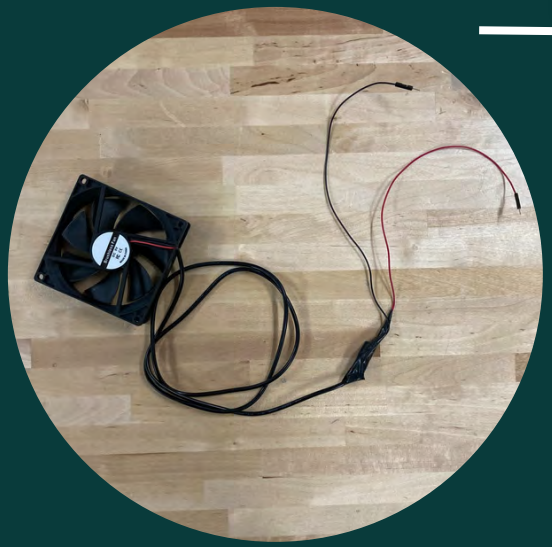
FUSION MODEL





This is our latest model we in Fusion 360. It has the updated grow beds and correct scaling.

HVAC

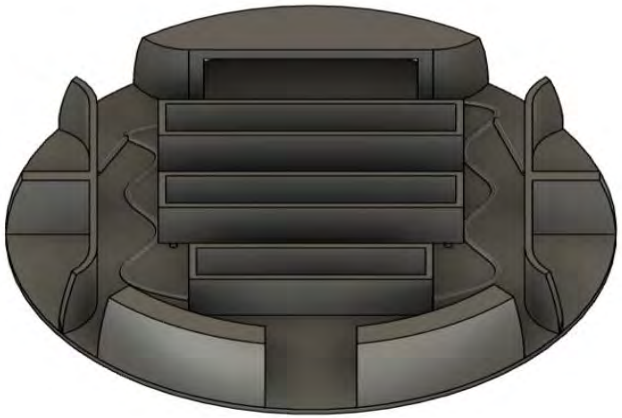


For our HVAC system we are using 4 fans that run every 30 secs. It will keep the CO2 constantly moving out of the Hab and into space.

WHY ARE WE THE BEST?

We believe that our design is the best as it covers all areas that are needed to have a working. It is a spacious area that can house a lot of bamboo

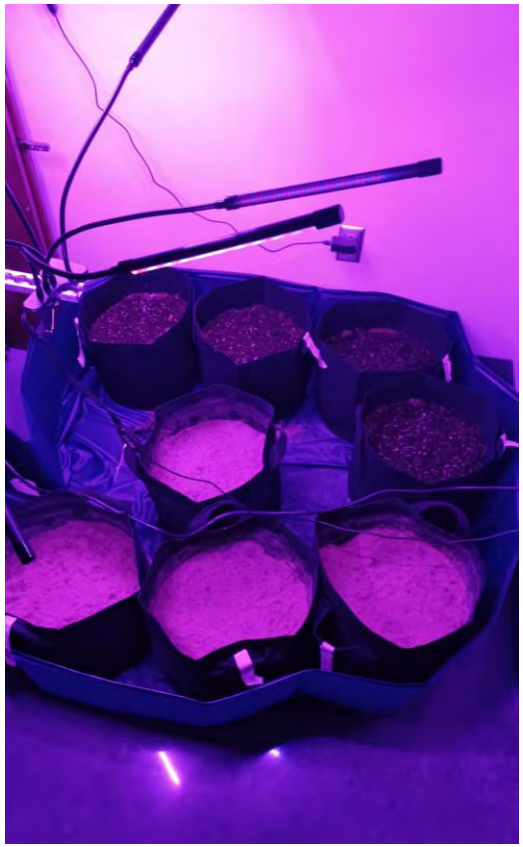
VIDOE OF OUR DEISGN WOKRING



Lunar Gravity

Normal Gravity

Our final design incorporated the optimal amount of growth space, workspace and utilities storage.



Description

Bamboo growth and greenhouse

During this project we were tasked to discover if bamboo could grow in a lunar regolith and what the best design for a lunar greenhouse would look like.

Lunar Grove

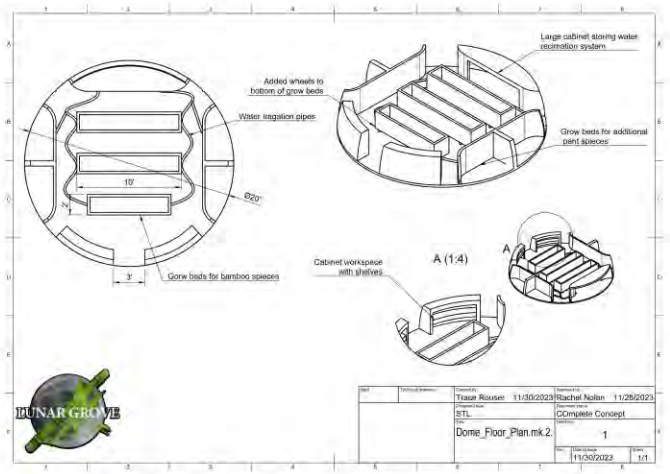
Lunar Bamboo Greenhouse

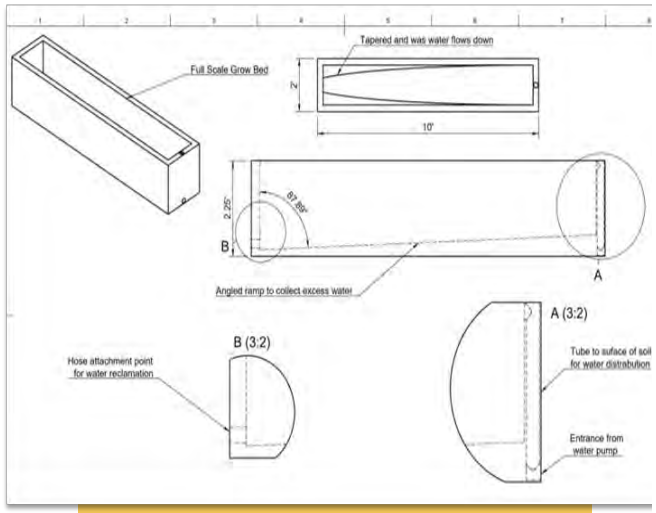
Meridian Technology Center
Mr. Mantooth
Rachel Nolan
Trace Rouser
Dylan Friese
Mary Branch

The Bamboo Success

We started growing our bamboo October 3 of 2023. Since then, we have observed growth in both our lunar regolith and control bags.

Our design incorporates a tube drip system for watering and a slanted bed for water reclamation that will operate in microgravity





Growth Space

The bamboo will be positioned in the middle of the greenhouse with other edible plants positioned along the outside.

These plants would be vitamin and mineral rich vegetables such as blueberries, spinach and strawberries.

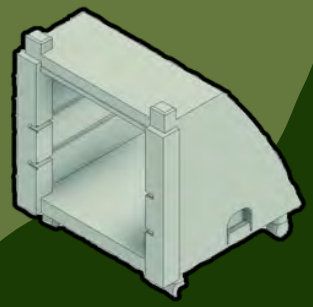
Workspace

There will be two shelves positioned on the outside f the greenhouse along with the other plants. These shelves will have optimal space for experiments, storage and provide room for the pump that will be used t distribute water.

Bamboo Applications

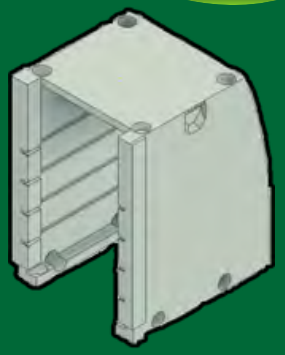
It will be beneficial for astronauts to have bamboo growing on the moon as it can provide sturdy building materials and can act as a carbon sink.

Greenery has also been shown to improve mental health and the fibers can be made into bandages for medical use.



Upper

- **Wheels that easily fit into the lower part.**
- **Latches that secure the top to the bottom.**
- **Heavy wheels to make the upper part be able to move easily on the ground.**

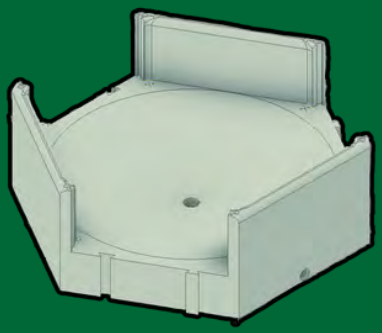


Lower

- **Slots for trays to slide in and out with locks keeping them from falling out.**
- **Holes on the bottom for rails to fit into for easy maneuverability.**
- **Lower storage area for extra trays and grow bags.**

Lunar bamboo grow bed

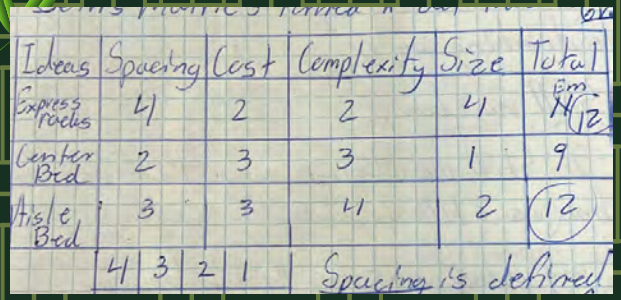
- Connect more than one grow bed together.
- Along with sliding walls to separate them.
- Water drainage for recycling.



Decision

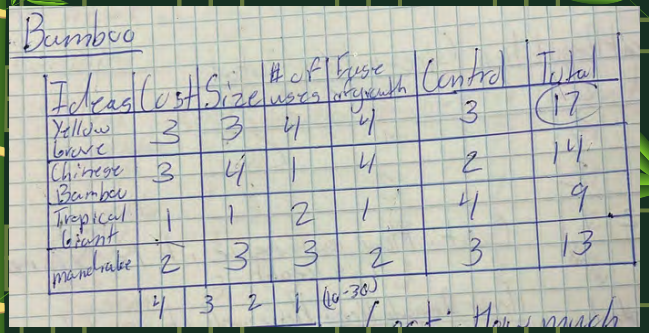
Using several different decision matrixes we found the most efficient way to solve each problem

Germination Control Matrix



Ideas	Spacing	Cost	Complexity	Size	Total
Express tracks	4	2	2	4	12
Center Bed	2	3	3	1	9
Aisle Bed	3	3	4	2	12
	4 3 2 1	Spacing is defined			

Bamboo Matrix



Ideas	Cost	Size	# of leaves	Rate of growth	Control	Total
Yellow Groove	3	3	4	4	3	17
Chinese Bamboo	3	4	1	4	2	14
Tropical bamboo	1	1	2	1	4	9
mandrake	2	3	3	2	3	13
	4 3 2 1	(10-30)				

Grow Bed

Ideas	Space	Mobility	Complexity	Cost	Performance	Total
A	4	4	4	3	3	18
B	2	2	3	4	2	14
C	3	3	2	2	2	13
D	3	4	3	1	1	12
1	2	1	2	3	3	11
2	3	1	3	4	3	11
3	2	1	2	3	4	12

Lunar Greenhouse Prototype

- Wood base spraypainted white
- 3D printed grow beds located on the center of the room.
- Set of tubes surrounding the room acting as our express rails.
- 3d printed grow bed with an interlocking design to maximize efficiency.
- White tubes inserted into the grow bed acting as our movable grow lights.
- 3d printed work stations that can either interlock into the grow bed or sit on the rails to slide around.

Bamboo

The bamboo chosen for our project was the Yellow Groove Bamboo.

- Running Roots
- Good tasting shoots
- Good O2 production

Selling Points

- Customizability
- Multiuse growing beds
- Mesh growing trays
- Express Rack-like design that follows the curve of the dome
- Rail system surrounding the greenhouse for racks and more
- Multi purpose work stations which fit onto the rails and the grow bed.

More Information

FLOWCODE PRIVACY.FLOWCODE.COM

Scan the QR code to see our project and process more in depth!

Bamboo Lunar Greenhouse!!

By The Bamboo Guru's

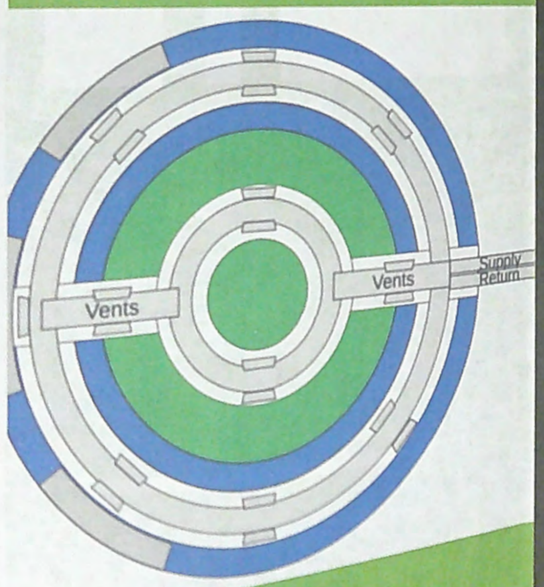
Elijah McCoun
Morgan Watson
Seth Johnson

Mr. Anderson
Billings Career Center

WHAT SETS US APART?

There is two things that make us different:

- Us being a vertical based hydroponics for bamboo
- Ours is a sustainable way to grow bamboo



TOO INFINITY...

CUSTOMER DISCOVERY

We have been looking into talking with others and seeing what more can also be provided in our service

BUSINESS

What we have is a planned business that can go above and beyond. Either completely reinventing the forestry industry, or making cleaning the airs of large cities. We see the potential and want to use it

AHEAD OF THE GAME

We are already thinking other prototypes don't do the following we do:

- Provide a sustainable nutrients for the bamboo
- tested in a closed environment

MOLD WHO?

Another key feature that we have would be incorporating shrimp into the water reservoir to manage mold and bacteria.

KEEPING IT CLEAN

We would have a sift/filter at the bottom of the base to do the following:

- Be able to keep solids out of the water basin
- Anything fall into it can be used has another form of nutrients

LUNAR BAMBOO GREENHOUSE

Presented by Mr. Bradburry's class:
Declan Talla, Oliver Milledge,
Hudson Bos, and Kaylie Monforton

Gallatin High School,
Bozeman Mt.

More info on our design and process

THE

GROWTH

Growth Variables

01 Water

A 50 Gallon Water tank will be used within the aeroponics system with the possibility of extension.

02 Lighting

Adjustable LED lighting that can be powered using power from solar cells.

03 Air Flow

We have various vents around the room that will evenly distribute the air around the rest of the habitat.

04 Nutrients

We have used floragro for nutrients that circulates within the aeroponics system.

05 Plumbing

The water is pumped out of the 50 gallon tank and up to the roof of the module where it is divided into each of the shelving segments

AEROPONICS SYSTEM

01 The Design

It is both customizable, as well as versatile for each type of plant that is grown in it. The gravity, or lack thereof, should not affect the way the plants get watered.

02 The Function

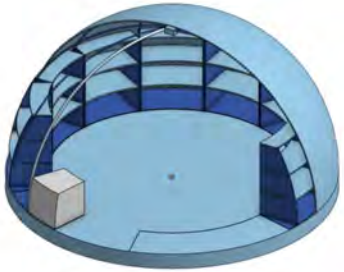
Our system sprays water for 15 mins and stands by for 45 minutes. The light is on for 14 hours of the day.

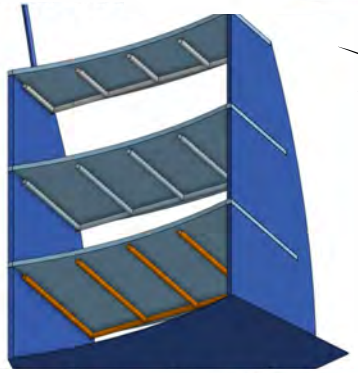
03 Results

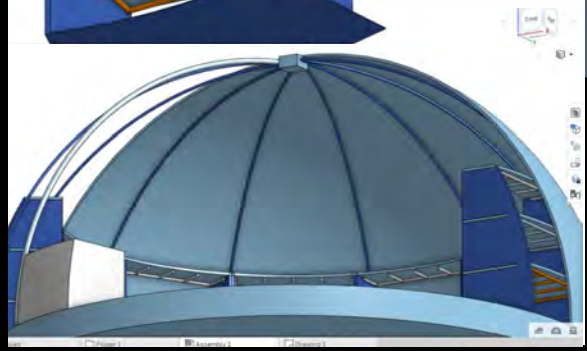
The system had a difficult time growing the bamboo due to difficulties propagating. However we had success growing spider plants.

GREENHOUSE DESIGN

Our design uses a modular shelving system. The shelves around the edges are all 30 degree segments based on the 20 foot diameter. They have been designed to be movable and replaceable. Shelves can also be removed to grow taller plants.







Problem statement

NASA needs a sustainable and cheap building material to use for construction and repairing on the moon and need a cheaper way to remove carbon dioxide from space moon bases. They plan on using bamboo because of its ability to quickly remove Carbon dioxide and as a temporary repair material.

Most plants in small numbers do not produce enough oxygen, nor remove enough carbon dioxide to be used in a small spacecraft and would require a very large volume. There are, however, several species of plants that photosynthesize large amounts of carbon dioxide and release oxygen back into the atmosphere. Bamboo has been studied extensively and is considered the most efficient at removing carbon dioxide from the air and turning it into plant fibers.

The long-term goal for a lunar base is to develop mining and manufacturing capabilities. Making things that can be used on the moon and things that could be sent to space from the moon. Many people are hoping to mine water ice from the dark segments of the moon and be able to use it for oxygen, and for fuel for spacecraft that could be launched from the moon.

https://www.nasa.gov/science-research/lunar-martian-greenhouses-designed-to-mimic-those-on-earth/

Video Link

bitly

Lunar Greenhouse Model

By:
Garrett Reese

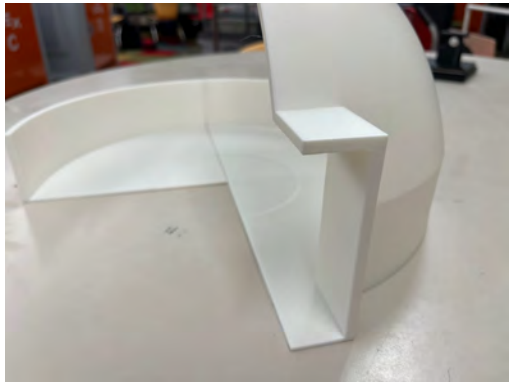
Engineering Design and Development
HTHS

Features:

- Extra strong material above bamboo to prevent it from breaking through the inflatable material
- Dome shaped roof
- Lights and irrigation
- Shaded roof
- Very Durable
- Large area for growing bamboo

helping people live on the moon

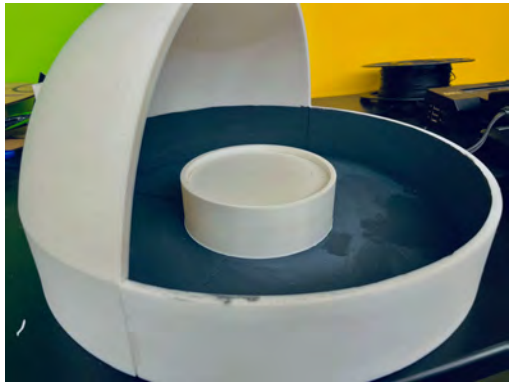
- Bamboo grows quickly and removes large amounts of carbon dioxide from the air
- Can be used as a building/repair material
- Bamboo can be eaten when boiled in water



The Facts

Some bamboo can grow up to 2 feet or more in a day, implying that they are removing a large amount of carbon dioxide from the atmosphere. Growing two or 3 feet per day would obviously be a problem on a small spacecraft. However, if you have a large growing space on the moon, it may be possible to grow bamboo not just for carbon dioxide removal, but also to utilize the plant stocks as a structural material.

Growing bamboo has a number of benefits. CO2 removal, most bamboo shoots are edible, act as a structural material for construction on the moon but also the act of growing it is a mental health activity for the astronauts—a little bit of Earth on the moon. This Bamboo garden is not intended remove all of the CO2 but is intended to act as a back up to the mechanical and chemical systems.



The Problem

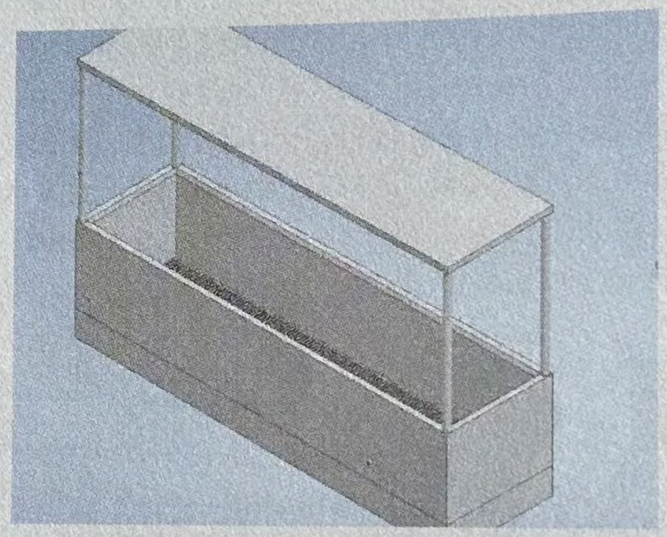
The next step in space colonization is to try to establish a permanent colony on the moon for mining and manufacturing capabilities. In order to accomplish this, a system must be developed using bamboo that provide any crew members on a colony with CO2 removal, material, and sustenance, while also being able to effectively grow and sustain the bamboo on the moon using lunar regolith.

Our Design

le chose our final design for a lunar amboo greenhouse based off of months of research into bamboo plants, orticulture, and design. Our bamboo selections for the astronauts will allow for effective material for construction and a delicious meal. he layout of the greenhouse allows for astronauts to have access to orkbenches and modular growth beds hich contain lights that stimulate owth in plant life. Our growth bed llows for easy access to different eights of bamboo when needed and ovides a quick method of watering bamboo. The structure of the dome rovides protection from radiation and stability that can last for decades.

GROWTH BEDS/LIGHTS

The design contains three growth beds that allow for different types of bamboo and height caps determined by crew members. Excess water can filter down through a mesh and be repurposed. The light system uses blue/violet lights to stimulate plant growth.



WATER SYSTEM

Our watering system enables quick and easy access and distribution of water throughout the greenhouse. Water is stored inside of workbenches and accessed using bags attached to hoses. These water can then be directly injected into the soil.

Lunar Bamboo Greenhouse

Grafton High School

Jack Burcher, Ben Calderwood, Raymond Gao, Karen Hu, Will Kim, Nathan Littreal, Mohit Patel, Will Shoemaker, Malikah Traore

Sponsor: Mrs. Stein

Meet the Team

Showcase Video

Growing Bamboo

We have tested using lunar regolith simulant (lava rock) on bamboo growth using pre grown bamboo in crushed up lava rocks as our simulant. During testing, the height of the top vegetation and color of the bamboo were all tracked. The bamboo received equal amounts of light and the temperature remained fairly constant. After weeks of observation, the bamboo has remained healthy and strong, proving that the regolith simulant, with fertilizer, can maintain bamboo species, and even encourage growth.

CAD MODEL

The layout of the greenhouse allows for complete customization by crew members. The heights of the bamboo can be determined by setting the ceiling of the growth beds to a set height. The structure of the dome uses high density polycarbonate to allow for structure stability that can last lifetimes.

PROTOTYPE

WHY GROW BAMBOO?

- **Carbon dioxide removal**: bamboo is very efficient at removing carbon dioxide from the air

- **Food source:** bamboo shoots are edible
- **Mental health activity**: may be helpful to astronauts
- **Construction**: bamboo stalks can be used for construction

LUNAR BAMBOO GREENHOUSE

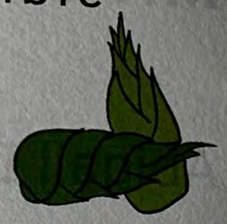
Tuscarora High School
Mr. Craig

Abigail Inyang, Kaitlyn Mathew, and Devon Spelbring

Lab Report →

The 3 types of bamboo we recommend growing are:

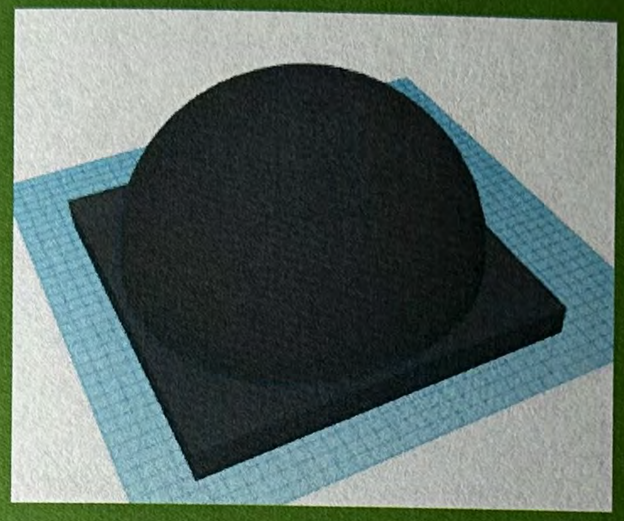
- **Moso**: good for construction, edible shoots
- **Madake**: easy to grow and harvest
- **Guadua**: great for construction, edible shoots



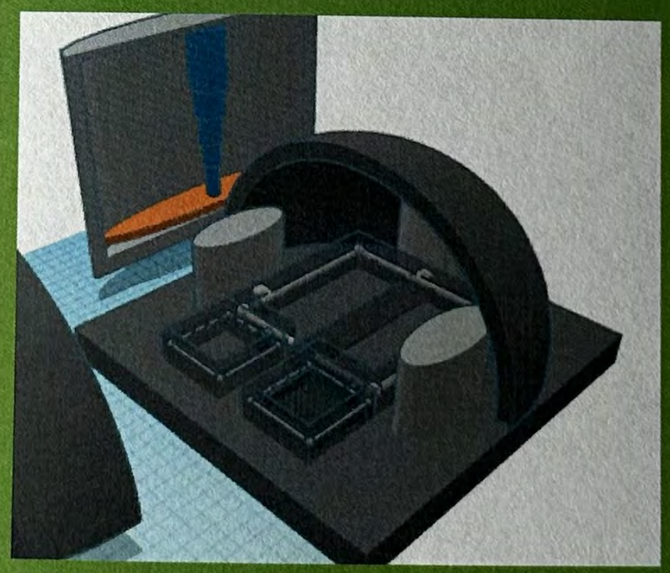
RECOMMENDED GROWING CONDITIONS

- White LED lights
- Well-draining soil
- 3 parts soil, 1 part compost
- 80mm thick potting containers
- Deep watering every 1-2 weeks

OUR GREENHOUSE DESIGN



GROW BED DESIGN



Scan for more information about our design!

GROWING PLANTS IN VOLCANIC ROCK

We grew buttercrunch lettuce in a soil mixture with volcanic rock to represent **lunar regolith**.

Here's what we found:

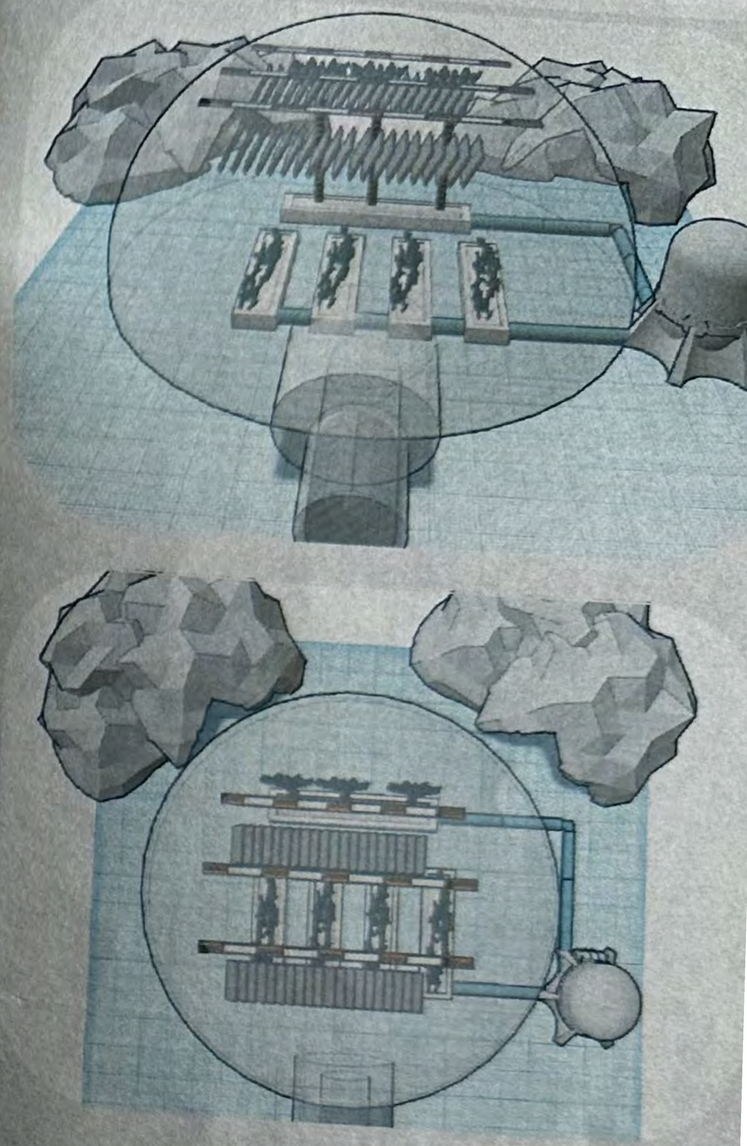
- **Yes**, plants can grow in volcanic rock
- They require **large amounts of artificial light** in order to thrive in the absence of sunlight

Results

- The initial plants grew. Lettuce reached a height of 2 inches.
- Then the plants were water deficient due to the lack of water absorbent soil (crushed lava rocks). Therefore we decided to water the plants in small amounts more frequently.
- During an experiment of using bananas as fertilizer, a mold outbreak occurred. It was determined that bananas are not a sufficient fertilizer.

OUR GOALS

- DESIGN A 3D MODEL OF THE GREENHOUSE
- MAKE A FUNCTIONING ENVIRONMENT FOR THE PLANTS
- DISCOVER THE BEST WAYS FOR THE PLANTS' OPTIMAL GROWTH
- CREATE FERTILE SOIL VIA LUNAR ROCKS AND COFFEE GROUNDS



NASA Hunch

Tuscarora High School
801 N King St, Leesburg, VA 20176

William Craig
william.craig@lcps.org

LUNAR BAMBOO GREENHOUSE

Plants

- Lettuce - Vitamin A, calcium
- Cabbage - vitamin C, K, and fiber
- Turnips - calcium, iron, magnesium
- Coffee - nitrogen, potassium

Bamboo

- Bambusa for eating
- Giant Timber for construction
- Muli Bamboo for eating and construction

PROCEDURE

1. Crush up lava rock soil and bake at 400 F
2. Build a greenhouse from a 12" x 14" cardboard box. Line the inside with tin foil and install LED light strips on the ceiling.
3. Seeds were planted 5" tall cups with the soil reaching 2.5". The seeds were planted 1" deep. The soil consisted of 1.5 cups of red lava rock soil and 2 tbsp of coffee grounds in each cup.
4. A humidity monitor and humidifier were added to the greenhouse to ensure humidity levels were maintained at 50-60%.
5. Plants were watered 1-3 times a week with 5-15mL, watering slowly and dumping out any excess water that was not absorbed.

ABOUT US

We're a part of the Technology Student Association at Tuscarora High School. Our group consists of 6 members ranging from Freshman to Sophomores.

GROUP MEMBERS

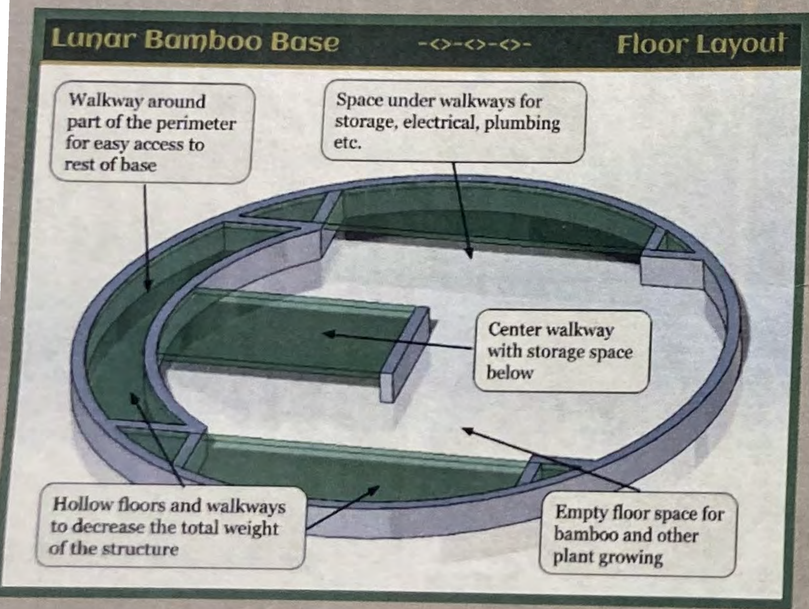
Laila Alsoleibi, Addison Bouer-Myers, Eileen Domingue, Aly Gold, Ella Quist, Sean Walker

Lunar Plant Base

Green Mountain Highschool - Ms.Flores

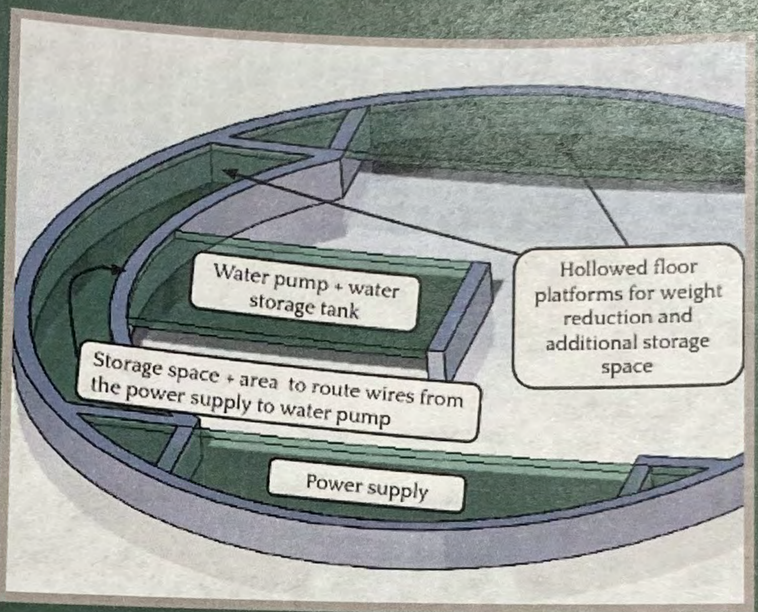
Luke Mitchell. Hayden Simonton,
Zach Williams

General Layout



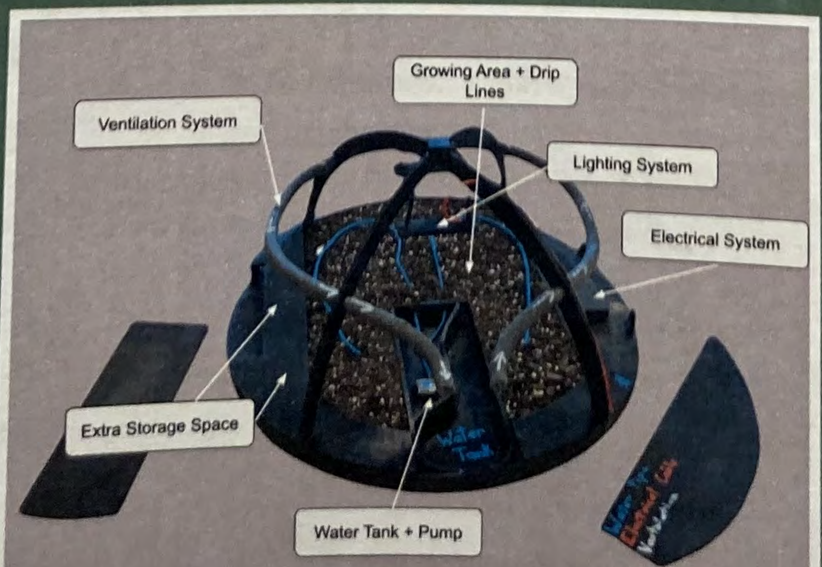
Prototype

Final Prototype Walk Ways



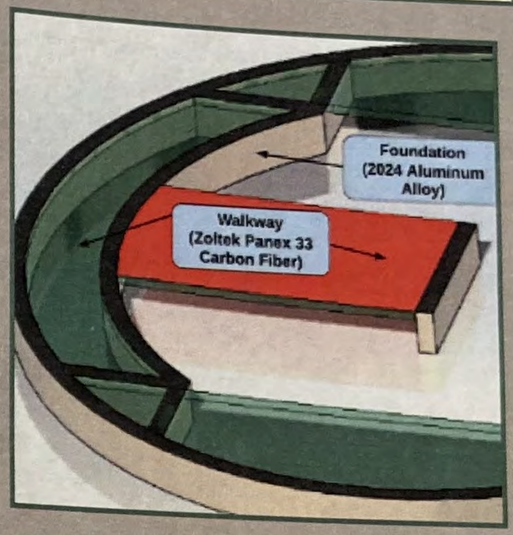
Why Raised Walkways?

- Raised walkways create out-of-the-way storage space for things like electrical, plumbing, heating, etc.
- Reduced Lunar Dust Exposure
- Easy mobility around the base
- Infrastructure protection
- Radiation Protection
- Allows for many different modular layouts



Materials

Part	Material	Density (ppcu)	Mass (pounds)	Volume (in³)
Foundation	2024 Alum. Alloy	0.1	6,672	65,960
Floor cover	Zoltek 33 Carbon Fiber	0.07	2,578	39,431
Dome	N/A	N/A	N/A	N/A
Total			9,250	105,391



Why aluminum?

- High resistance to corrosion
- High weight to strength to cost ratio
- Resistance to UV damage.

Why CF?

- High stiffness and strength.
- Lightweight.
- Heat/UV resistant

Testing

Bamboo Growing Test (spoiler nothing grew)

Day 1

Picture of our bamboo seeds planted on day 1 right after placing lunar regolith and watering.

Day 24

It has been over 3 weeks and nothing has sprouted. In concluded this test is a failure.

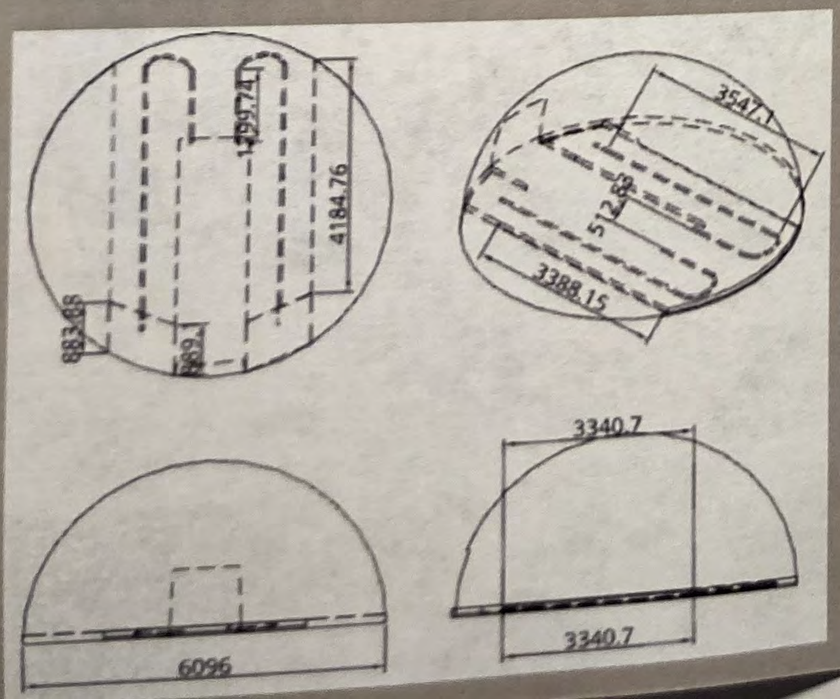
Water Drainage

Water drainage is a major part in not just this project, but watering plants in general. Watering drainage is a crucial need for the plants, as with no drainage of the water the plants become flooded and have a more difficult time growing. To solve this problem we have strategically placed drainage holes leading to a sub-floor below the main dome structure, which is lined with a thin layer of a corrugated metal, sloped slightly downward towards the water tank area, to then pump it back up, and recycle the water.

Other Potential Problems

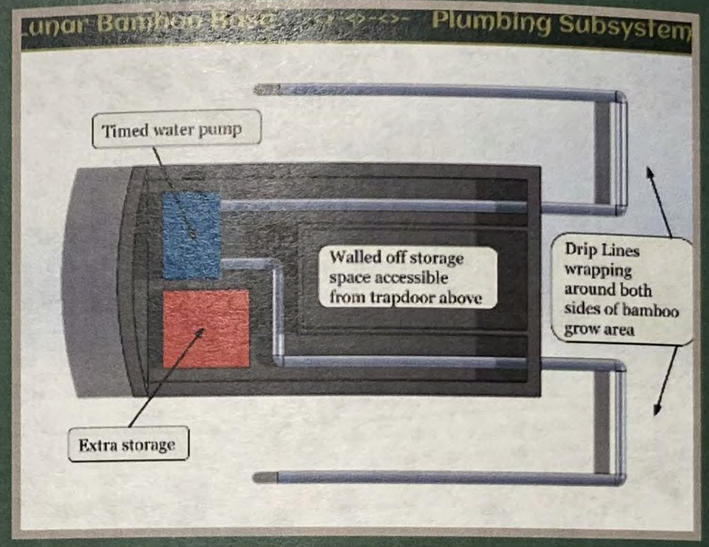
While the main problem is to design and create an effective dome design to be able to survive the moon, there was a large problem that was overshadowed. While Earth has a atmosphere that saves us all from asteroids, the Moon does not have any atmosphere, meaning there is no protection from asteroids crushing the base. A simple asteroid travels anywhere from 38,000 mph to 55,000 mph. Even a screw size asteroid would be catastrophic to the base

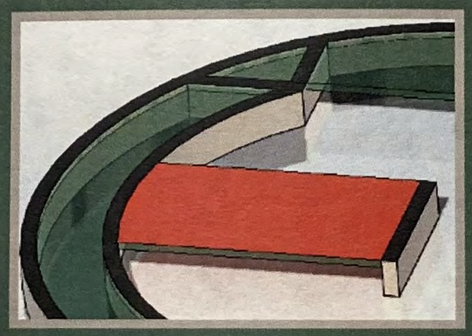
Technical Drawing



Other Subsystems

Plumbing Subsystem



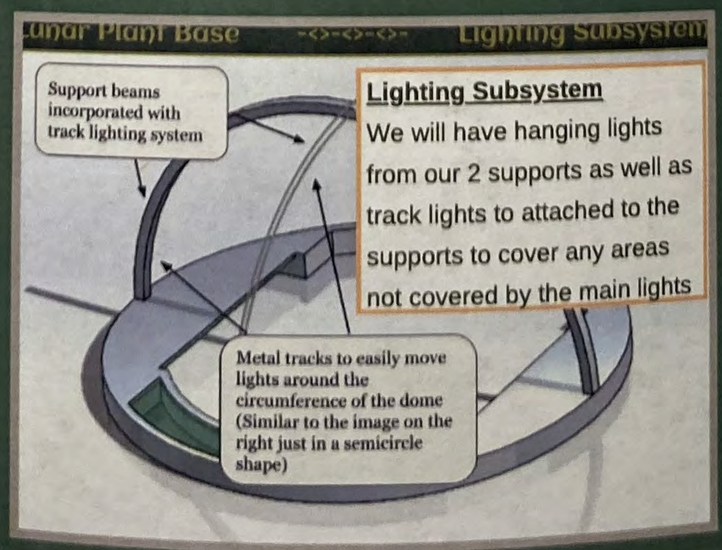


Location

The plumbing subsystem will be located under the central walkway facing the center of the base

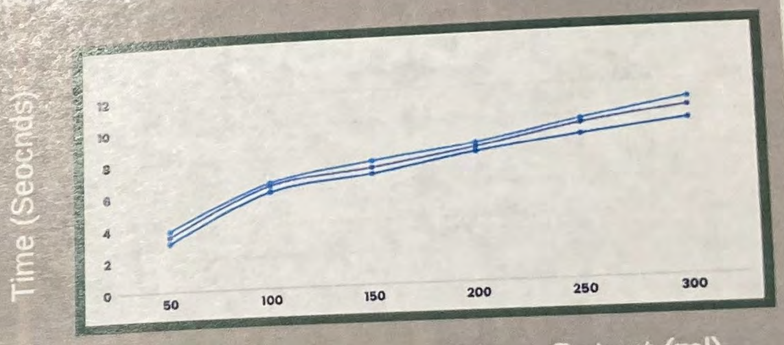
Lighting Subsystem

For our lighting subsystem, we decided to have a set of track lights that could be moved up and down the 2 support beams. Additionally, as seen in our prototype, we have a regular set of 4 hanging ceiling lights attached to the top of the dome



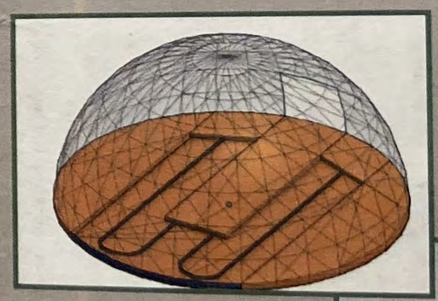
Testing continued...

Water Pump Testing

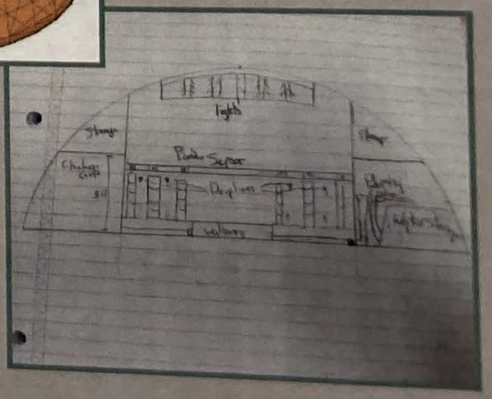


What We Learned

- how long the pumps have to run every hour for the plants to have enough moisture to grow.
- we would need about 9.5 gallons of water every 8-10 hours pumped through and dispersed throughout the grow beds to give the bamboo the correct amount of water



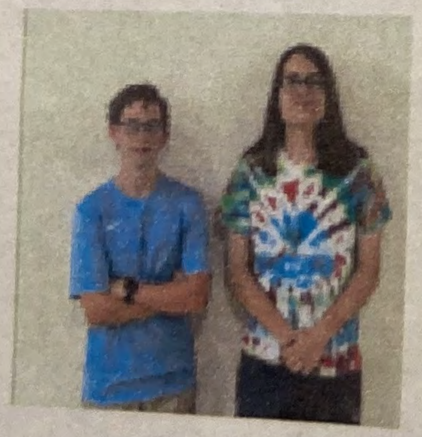
Early Progression of Prototype



Next Steps

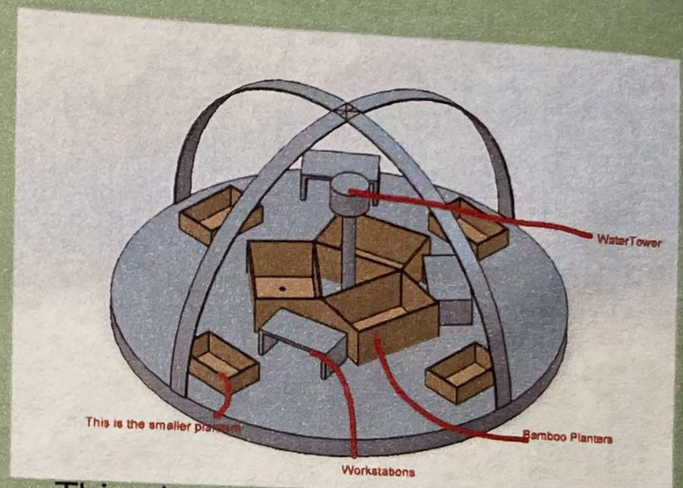
- Add finishing touches to CAD
- Continue working on protype
- Setup working lights for protype
- Setup working plumbing for protype
- Create more subsystems for storage and usability around the base
- More detailed CAD
- Ventilation

Lunar Bamboo Greenhouse

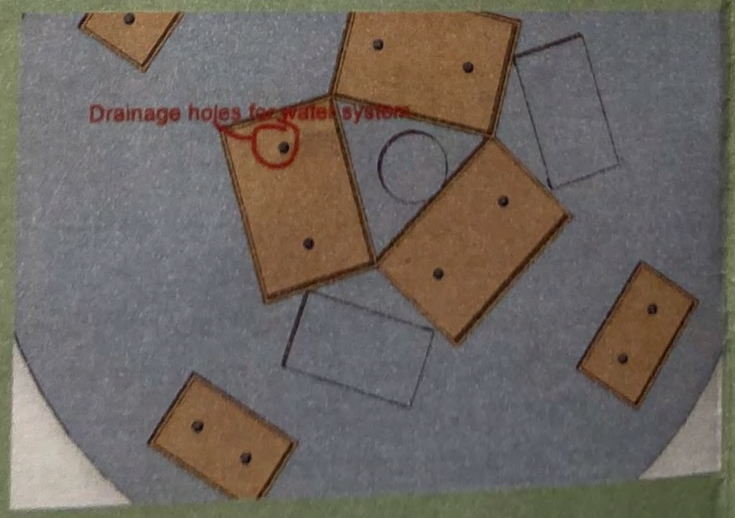


BY:
Brogan Williams
Rex Roy
Green Mnt. HS,
Flores

CAD Drawings



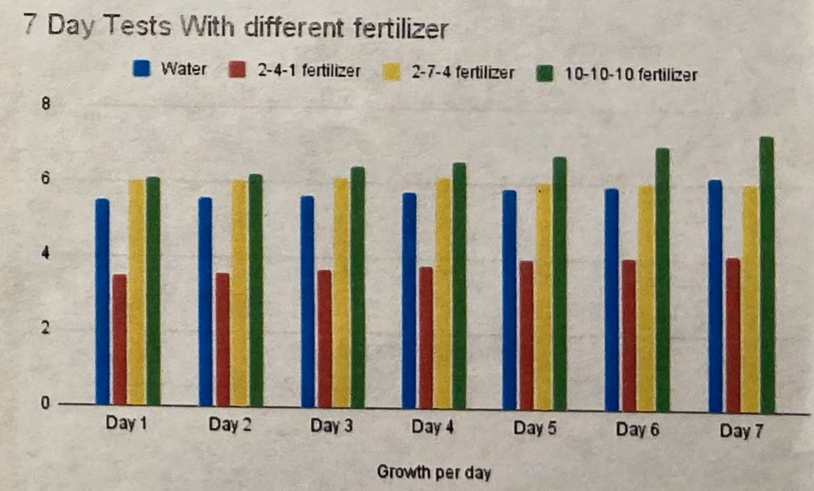
This shows the base layout of the Greenhouse



This shows the drainage holes for the water system

Testing data:

Growth per day	Water	2-4-1 fertilizer	2-7-4 fertilizer	10-10-10 fer
Day 1	5.5	3.5	6	
Day 2	5.56	3.56	6.06	
Day 3	5.62	3.67	6.14	6
Day 4	5.75	3.78	6.18	6
Day 5	5.87	3.98	6.06	6
Day 6	5.92	4.05	6.06	7
Day 7	6.2	4.13	6.06	7



Air Circulation:

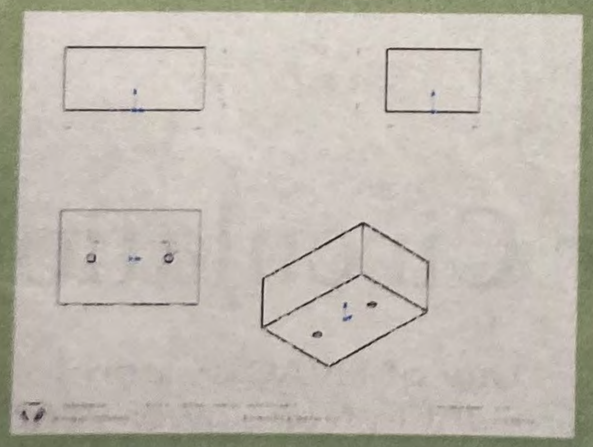
- Use of HVAC systems
- CO2 brought in from lower vent abov doorway
- O2 taken out from vent above CO2 vent

Watering System:

- Center of greenhouse
- Drip sprinklers into planters
- Can cycle between water and liquid fertilizer
- Sensors in central system
  -Detects bamboo growth
- Based on a real greenhouse system

Planter:

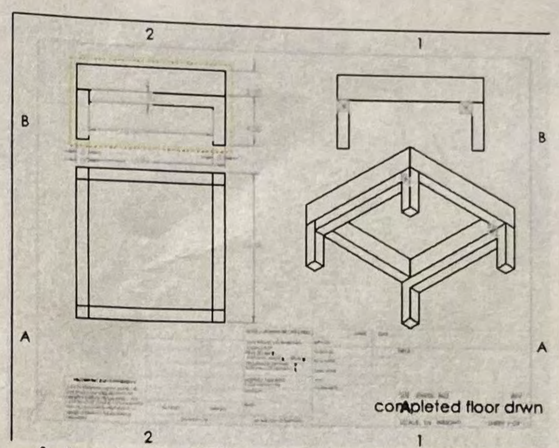
3 central bamboo planters
4 alternate planters
Bamboo planters 3ft by 1ft boxes
Alt planters 2ft by 0.5ft boxes
Old planters had back wall and roof
Reduces weight without it
Sensors in water tower sense growth



A technical drawing of our planter

Fertilizer:

- A liquid solution
- Used in a real greenhouse
- Able to be administered with water



A technical drawing of a floor tile

Tiled floor

- 1ft by 1ft tiles
- Titanium supports
- 0.5ft off the ground
- Pipes and wires run underneath
- Allow walking & easy access to pipe/wire repair
- Tiles carbon fiber

Lighting

- Mixture of red, blue, and white LED strips
- Best colors for photosynthesis
- Lining the supports of the dome
- Lights can change color
- Lights turn off for half the day

Pictured are red and blue light strips

Contact Us:

QR Code to Our website

Rex Roy

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Brogan Williams

Phone: (540) 550 - 0301

Email: 2237124@jeffcoschools

NASA HUNCH

LUNAR BAMBOO GREENHOUSE

Merrick Melland
Max Smith

Website Link

Here you can find more information about our project

*If presented with an error after scanning the QR code click *continue home page*

ABOUT OUR PROJECT

We have worked to create a digital and physical model of a lunar greenhouse and attempt to grow bamboo in harsh moon-like conditions

OUR DIGITAL MODEL

We created a digital model in Autodesks Revit in order to have a complete, and easily navigatable example to display our ideas.

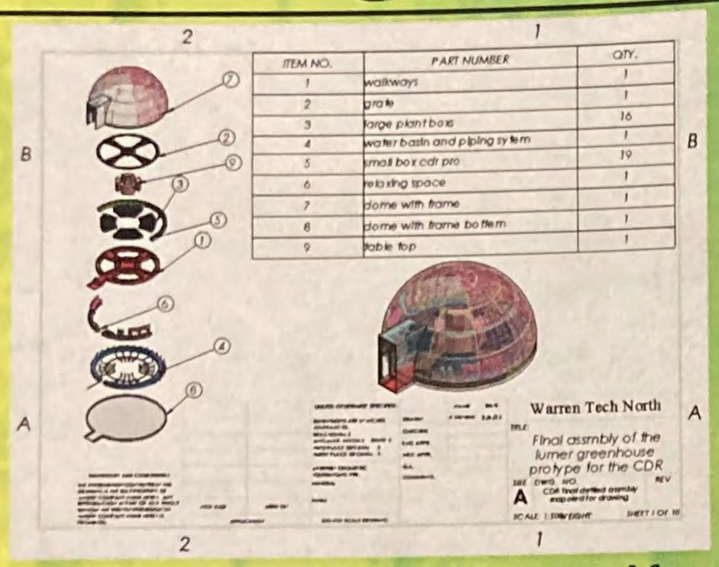
OUR BAMBOO TRIALS

We planted bamboo cuttings in various conditions revolving around a granite dust we used as a lunar regolith substitute. these mixtures mainly included percent amounts of fertile soil and/or fertilizer.

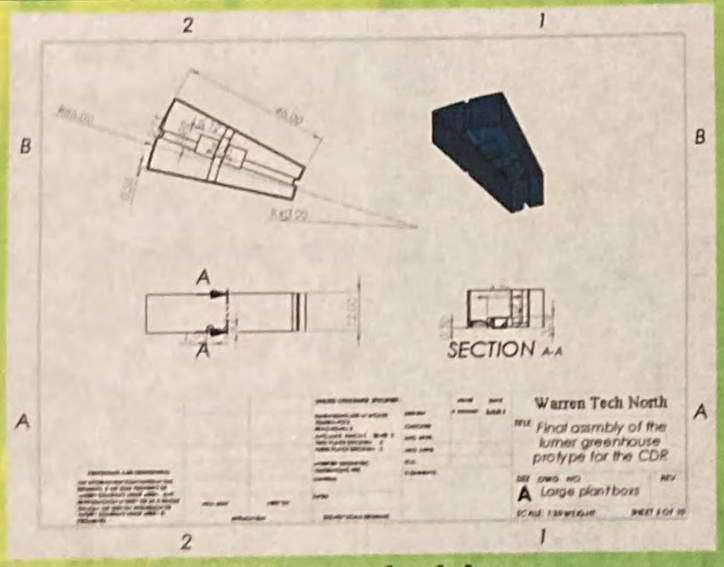
OUR PHYSICAL MODEL

We made a physical model as a real reference point to present, practically making our digital model tangible

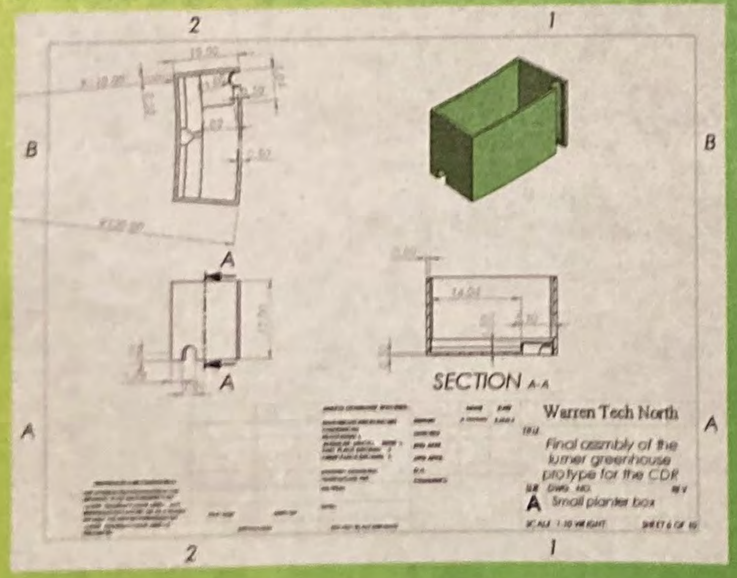
Drawing sheets



CDR final detailed assembly exposed for drawing



Large inner plank boxes



Small outer plank boxes

Model

Assembled view with dome

Assembled view without dome

Uper dome with air ducks, fans, lights, and frame

Grate with holes so you can see inside storage area

Working area with scissor lift for more working space

Inter changeable pots (iner and outer)

Walkway with underground storage for grate and working area

Relaxation area with bench, worm bin, and heater/cooler

Water basin with bladder and piping system connected to drip system

Lower dome

Lucas Coto and Audrey Merecki

Warren Tech North- 11325 Allendale Dr, Arvada, CO

Advance 3D printing - Mr. Brown

Email: lucascoto011@gmail.com

Email: AudreyJMerecki@gmail.com

Logo/mission patch

Website

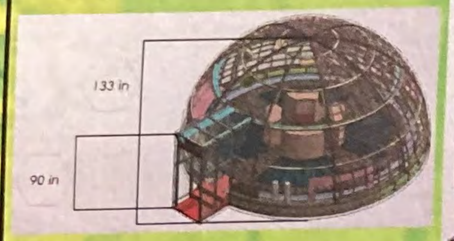
Team #2

NASA HUNCH

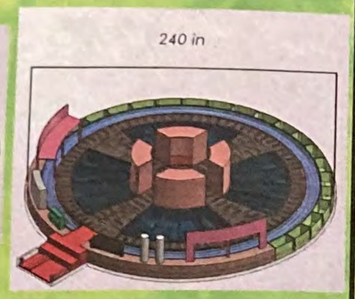
Lunar Bamboo Greenhouse

Layout

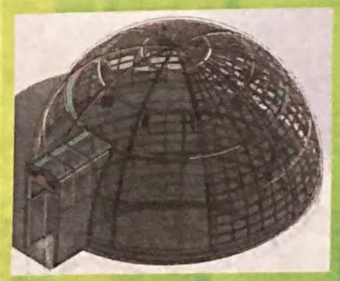
Assembled views



With dome



Without dome



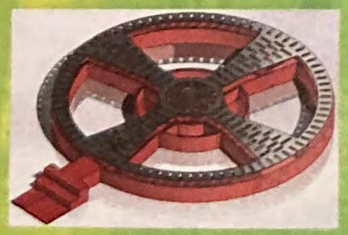
Frame with air ducts, fans, lights, and chicken wire

Dome frame: Carbon Steel

Air ducts: Aluminum

Inner and outer interchangeable pots

Pots: Crude oil-based plastic polypropylene



Underground storage walkways covered by a grate

Storage Grates/Walkways: Polyvinyl Chloride Alloy - PVC

Water basin and piping system

Bladder Tank: Fiberglass

Plumbing : Galvanized steel

Relaxing area with benches and tabletop

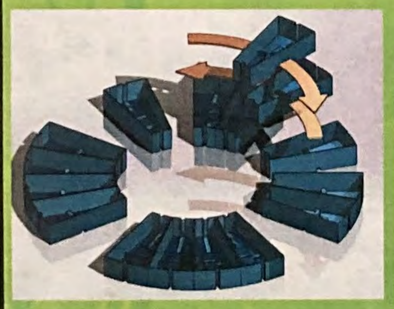
Relaxing area: Fiberglass

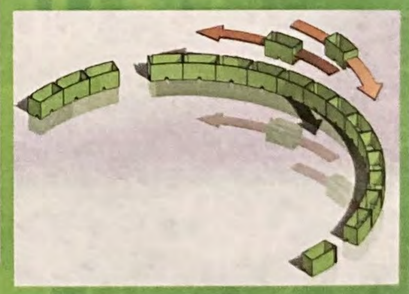
Working space: Magnesium

Interchangeable Pots

Increased adaptability

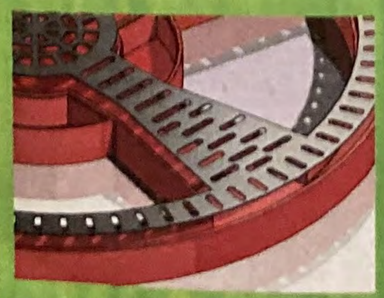
- Plants can be moved closer or farther away from vents
- Individual water valves allow dry and wet plants to be in the same pot
- Easy to remove unwanted or diseased plants
- Astronauts can experiment with companion planting in space





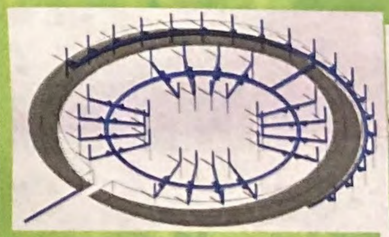
Underground Storage

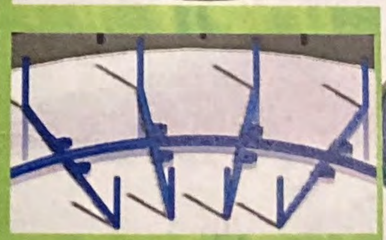
- Storm-drain-like walkways are easy to grab and see-through
- Divided sections so it's easy to open and close
- About 87.6 cubic feet of storage

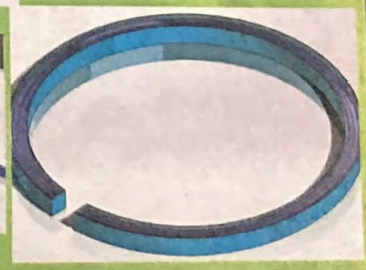


Water Storage and Transport

- A volume of 50.2 cubic feet or about 375 US gallons or 1419.53 liters
- Top of storage clear so water can be viewed
- Valves for every possible divided area

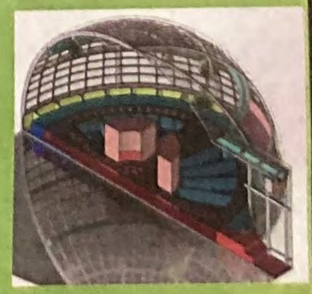






Looking Ahead

- Further research on materials
- The other half of the model
- More features to include and improve on



Special thanks to Bamboo Garden and the Ned Jaquith Foundation

Reasoning Behind Our Bamboo Greenhouse

The goal of our project is to create a Greenhouse for a lunar base that maximizes space and efficiency, as well as helps with the absorption of CO_2 gas from the base through the use of bamboo. Our design includes many elements that are key to having a successful greenhouse on the moon. We have created a system that can adapt to different types of plants in the future, as well as its main/current purpose of growing bamboo for structural and edible purposes. Details on our systems are located inside!

Meet The Team

From Left to Right:
Ryan Miller, Carley Kilburg, Virginia Romero, Kingston Bright

Contact Information

Virginia Romero: 2110159@jeffcoschools.us
Ryan Miller: 2069125@jeffcoschools.us
Carley Kilburg: 2110185@jeffcoschools.us
Kingston Bright: 2064457@jeffcoschools.us

CHATFIELD SENIOR HIGH SCHOOL - BRUNETTI

Lunar Bamboo Greenhouse

CONCEPTS BY: TEAM RVCK

What We've Done

We built a model that shows each part of our base. Our model shows where water would be stored, the electrical layout (including lighting, sockets, and wire routs), the growing layout, storage options for further adaptions of the green house. Our is at a 1:12 inch scale, demonstrating how the layout would be as close to real life as we can.

While we were unable to grow our own bamboo types, we researched its ideal growing conditions and its nutrient prerequisites and adapted our design to those specifications in order to ensure that the bamboo will thrive.

Our Design

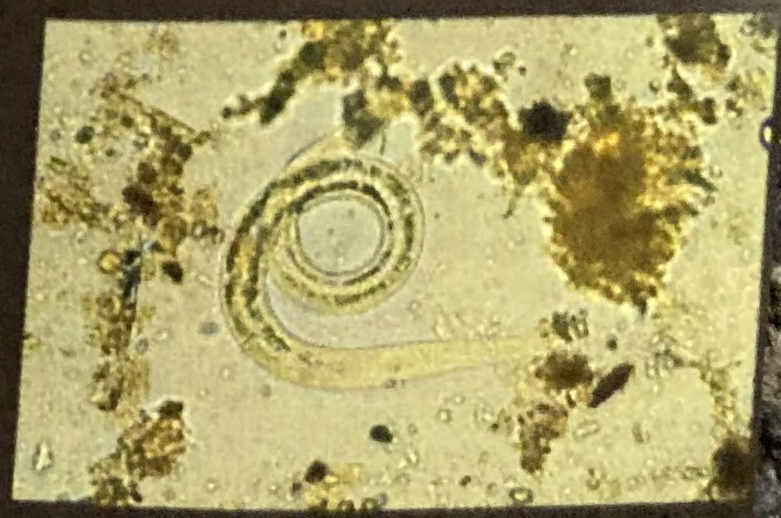
What sets our design apart from other groups is our layout, moving and stackable beds, water/humidity retention, and our growing method-- microbes.

Our layout is original and easy to work with, the workstation has six sockets for an easy connection to the electrical system of the base. The beds have small wheels to move them around as needed, in order to avoid any puncturing of the dome there is a thin sheet of HDPE plastic that runs adjacent to it which will have the LED strips (both UV and regular) attached, the and we have a collapsible arm in to facilitate watering.

The QR code below goes into more details on our project and has additional images

What's Next?

Our next steps are to toy with the Soil-to-regolith ratio that will keep our microbes alive and producing their vital nutrients fo plants to thrive.



Bridgeland High School

Instructed by David Laughlin

Yusr Ahmed, Jasmine Daraphet, Melissa Macias, and Addison Vertucci

PROJECT MJAY

Bambootifying the Moon

WHAT IS OUR LAYOUT?

The greenhouse format is designed to use the dome's curvature as a tool instead of a weapon. The curved shelves on the perimeter make use of otherwise dead space as a result of the dome's bend. The central grow bed takes advantage of the tallest point in the center of the dome.

WHY DRIPPING IRRIGATION?

We chose to use a drip system because it will allow us to deliver water directly to the base of our bamboo plants and provide precise control over the amount of water each plant receives.

WHY DWARF BUDDHA BELLY?

Dwarf Buddha Belly is a species of bamboo characterized by its short stature, thick trunk, and clumping roots. The height and clumping roots make it easier to contain within a space while the thick trunk still allows for maximum carbon dioxide absorption.

Rubric & Feedback

Presentation

Lunar Bamboo Greenhouse

Contact Information:

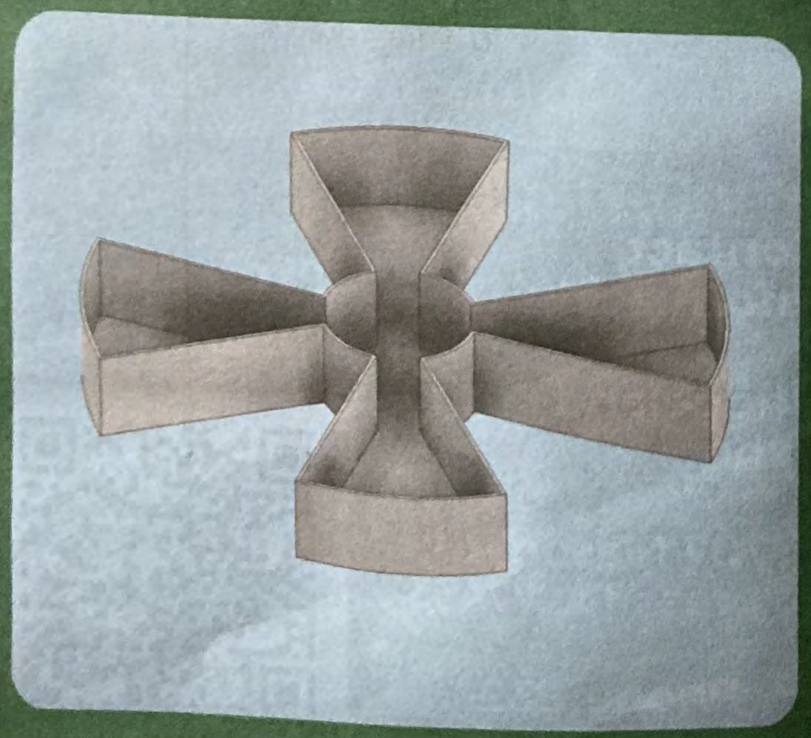
Bridgeland High School

10707 Mason Rd, Cypress TX, 77433

- Phone: 832-349-7600

Project Resources:

Lunar Bamboo Greenhouse



Growing Bed

AIR PURIFIER/ DEHUMIDIFIER SYSTEM

The dehumidifier takes in most air from its surroundings to cool it to dew point temperature. When water droplets form, they fall into the water container. The air is then reheated and released. We included one because plants produce moisture vapor that can build up into an inconvenience.

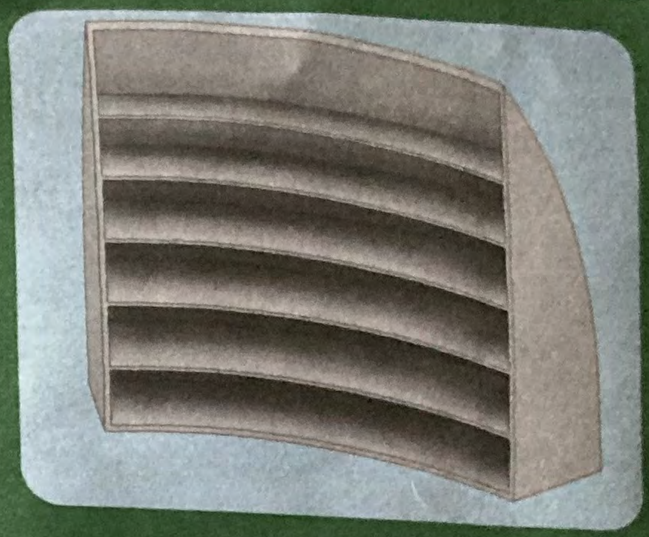
Our air purifiers/scrubbers take contaminated air into the device where layers of filters purge the air of dirt particles and pollutants. Then thin layers of titanium dioxide coated tubes take the air to a UV light that converts ethylene into water and carbon dioxide (reactants of photosynthesis). We included one because plants release byproducts (ethylene) that can be harmful if not purified.

SOIL NUTRIENTS

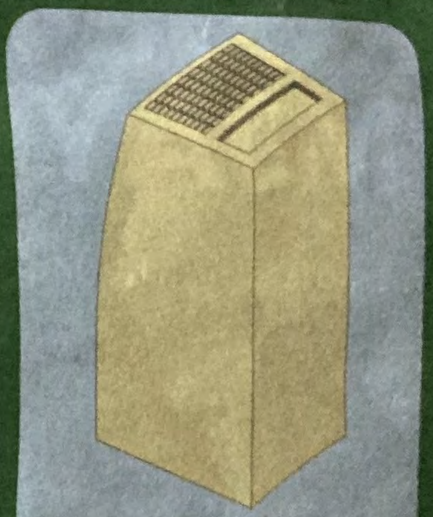
The bamboo will be planted in a Earth soil/ lunar regolith mixture. Bamboo is already capable of growing in dry soil and volcanic ash environments, so we know with a little supplemental soil (and its nutrients), the bamboo will thrive.

GROWING AREAS

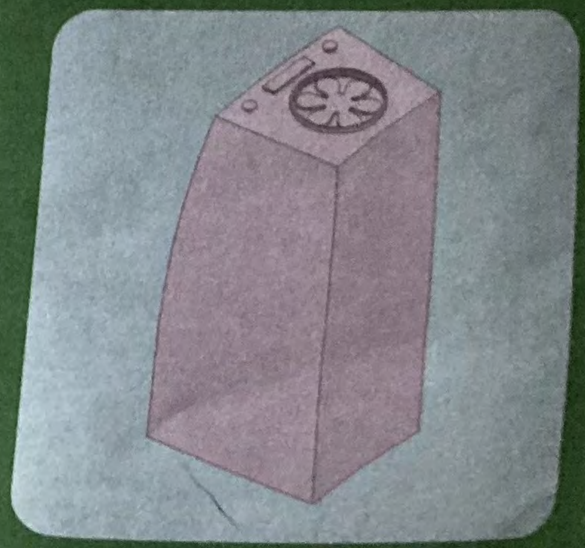
The grow beds are designed to optimize space while still allowing the astronauts to comfortably access any plants being grown and navigate the greenhouse.



Growing Shelves



Air Dehumidifier



Air Purifier

Lunar Greenhouse

Student: Rose N. Young
Teacher: Alex Jones
School: Shattuck St. Mary's

Growing Bamboo

Materials:

- Indoor Greenhouse
- Exolith Labs Lunar Regolith Simulant
- Perlite
- High Nitrogen Fertilizer
- Humidifier
- Growlight
- Four Types of Tropical Bamboo



Timeline:

Mid-November:

- Saturated seeds in warm water for 24 hrs
- Planted seeds in regolith soil
- Watered plants every other day

Early December:

- No growth
- Moved to focus on greenhouse after waiting several weeks for sprouts

Results:

- Inconclusive
  - → Was not able to produce results

Changes/Recommendation:

- Create proper soil
  - → Need organic material and micro-organisms to support growth
- Recommend hydroponics over traveling with many materials to

Prototyping the Model

Original Brainstorm:

- Use non-stranded wire for skeleton of structure
- Cover in canvas
- 3D print components
- Draw blueprints in AutoCAD

Research:

- "Bones" of inflatable modules look like arches
  - → Wanted to change to geodesic dome
- Lunar structures can bear more weight due to lesser gravity
- Dome must be able to protect astronauts from radiation

Prototype 1:

- Create round top for bowl
- Paper mache
- 3D printed base
- Base scale off of bowl size


Bowl Rounder


Base


Bowl + Top


Paper Mache

Prototype 2:

- Scale size 1:20
- Inspired by North Face geodesic tents
- Made with craft sticks
- Components are made of bass wood




Final Recommendations

Water Supply:

- Two 100 gallon tanks
- Go under outer shelf/work area

Plumbing:

- Water lines go directly from grow beds to a filter and then return to tank
- One line per grow bed

Lighting:

- Grow lights to go directly over plants
  - → On daylight cycle
- Overhead lights for the rest of the greenhouse
  - Only used when people are present

Grow Beds:

- Custom grow beds to maximize circular floor
- Place in the center of the room so the bamboo can grow higher
- Add support rails on the side where more beds could be layered

Work Areas:

- Two 4ft desks on either side of the grow beds
- Additional workspace around the perimeter of the dome

About Us :

We are high school students from Minnetonka High School. We are working in design and prototyping strand of NASA Hunch. Our project for this year is the Lunar Bamboo Greenhouse, where we designed a proper greenhouse for growing bamboo on the moon. We overcame challenges such as allocating space, growing the bamboo, designing mechanisms, and 3D printing scaled model prototypes.

Contact Us

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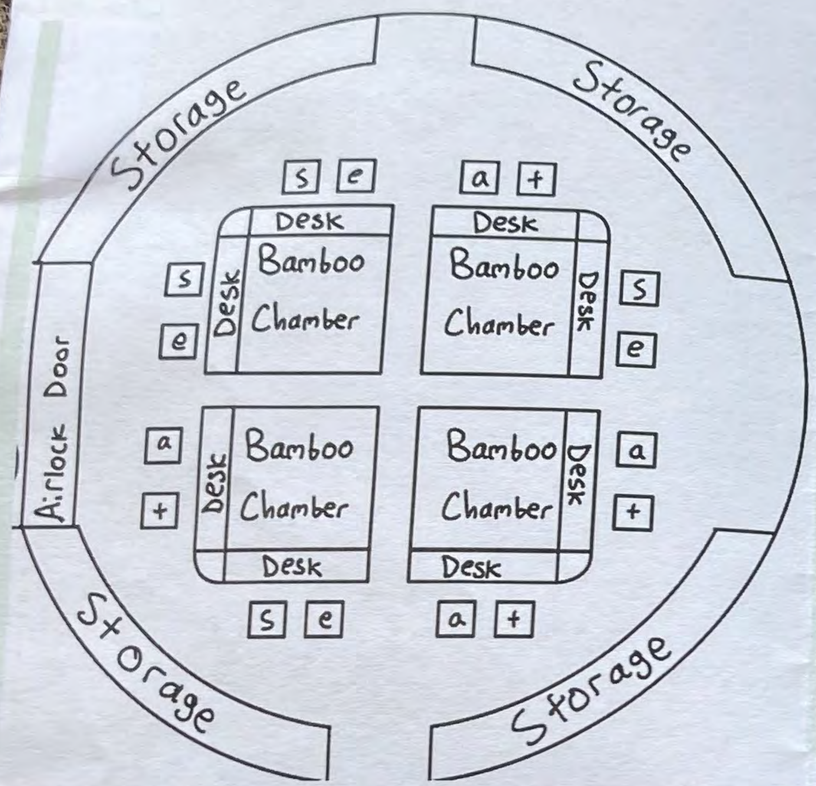
jacksonhempel@icloud.com

Jon-Paul Merry-612-505-2171
jonpaulmerry@gmail.com

MINNETONKA

Minnetonka Minnesota

BAMBOO GREENHOUSE - JACK HEMPEL AND JON-PAUL MERRY



The Greenhouse:

- When designing the greenhouse, we wanted a simple, yet effective layout. We allocated a lot of space to both the growth chambers and the work spaces for astronauts. The work desks come out of the growth chamber walls, allowing the astronauts to work right next to their bamboo.
- All of the water pump systems for the bamboo are built underground, allowing for the ground level to be allocated for the essentials. The ground level includes desks, storage areas, growth chambers, and lighting systems. Underground, there are the water pump systems and areas for the astronauts to access for maintenance.

Everything In-Between:

- **Carbon Sequestration with bamboo:**

The dendrocalamus asper bamboo will absorb the carbon from the air and store it in its roots. This will allow for the bamboo to absorb more carbon from the air than other plants.

- **The watering process (via pump):**

The four bamboo chambers will receive water through a timed pump. You can choose when the pump will water the bamboo, at certain time intervals the pump will administer water directly into the roots of the bamboo. This water is stored in a reservoir, water is added to the reservoir from pumps going into the habitat module as well as drainage water from the bamboo (this reuses water from the plants)

- **The mixture of gases between modules:**

Fans from outside modules will pump air if needed through the four rods on the sides of the dome. This will allow the greenhouse to have its own type of thermostat system, depending on the humidity. Also, the airlock ensures that the gas/air from astronauts entering thr habitat will be the right temperature.

- **The ability to grow other types of plants:**

Our growth chambers allow other types of plants to grow, such as corn bean and squash together, as well as different vegetables.

The Growing process:

- For our lunar stimulant, we used lava rock that we crushed up. We then put the germinated seeds in the soil with nutrients and watered it regularly. We attempted this multiple times with different seeds throughout the year but saw no process with growing.
- For our control, we implanted the germinated dendrocalamus asper seeds into regular soil and attempted to grow the bamboo. We saw no progress even with the control soil.
- The greenhouse is able to grow bamboo, as it provides the right temperature and environment for it to grow. The greenhouse provides warm light, as well as a fully functioning watering system.

Bamboo Boys

Tri-County RVTHS - Franklin MA

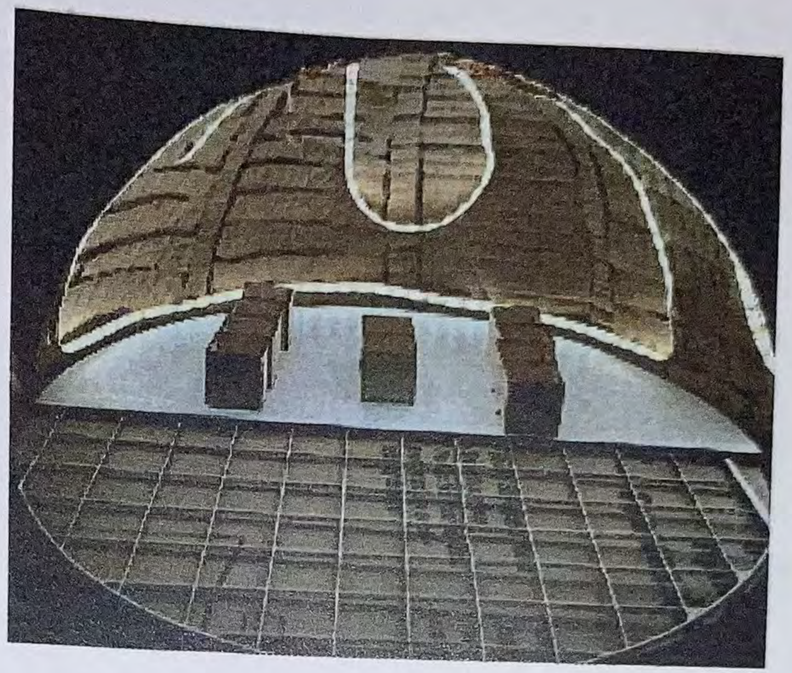
Lunar Bamboo Greenhouse

Group Members: Cayden Bourassa, Parker Loconto, Aaron Mushlin, Jonah Scott, Loatchwel Joseph

For more information about the certain areas, scan this code:

Email: tricountynasa@gmail.com

Teacher: Mrs. Magas



Project Requirements

- Ventilation
- Automated Watering
- rearrangeable layout
- Lighting
- walkways and work areas

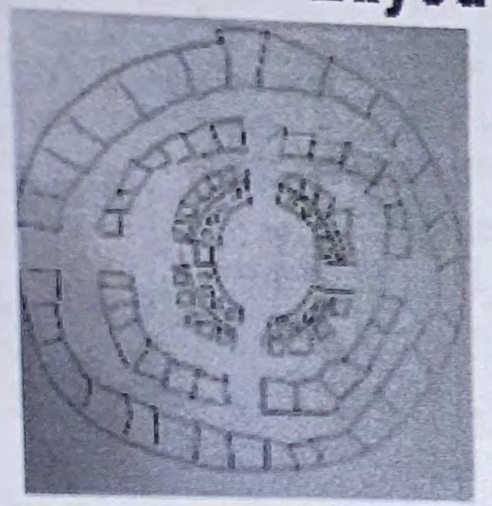
Design Highlights

- Fully rearrangeable grow beds layout
- Break/Work area
- CO2 reduction
- No possibilities for trip hazards
- productive lighting

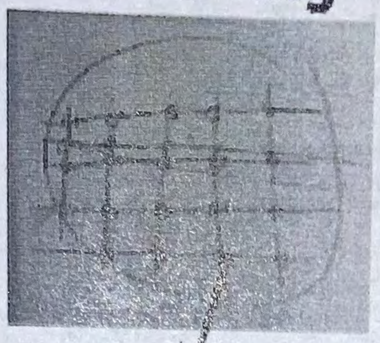
Testing

We had a lot of testing with the layout, growbeds, watering, ventilation and lighting of the greenhouse optimal area and growth for the bamboo. With this testing we have found out things that could work and things that couldn't.

Layout

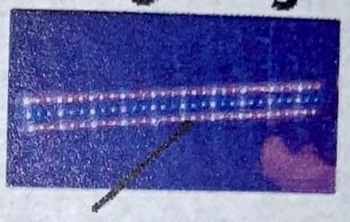


Watering



Grid style layout across roof

Lighting

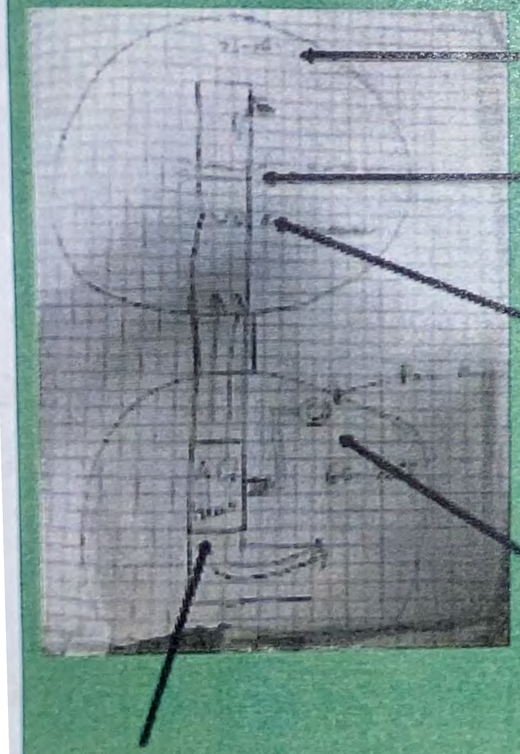


Full Spectrum Lighting

Substrates and Fertilizer

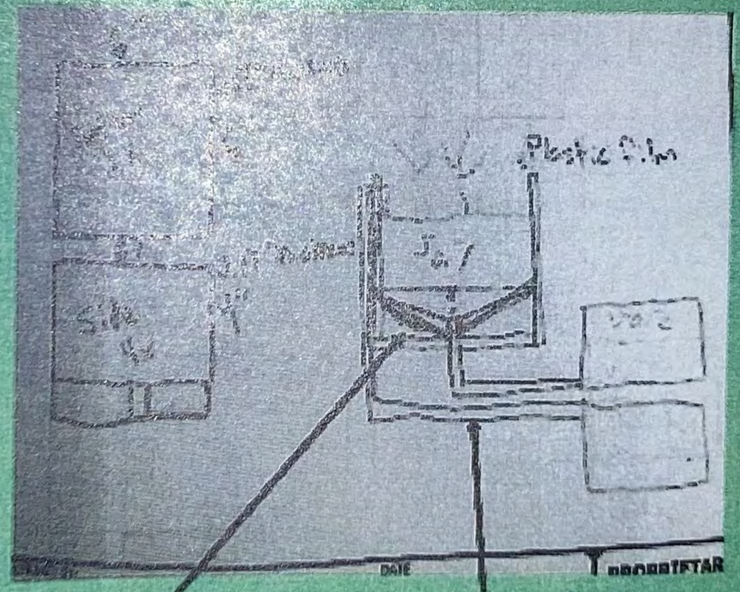
We have a couple different ideas for our substrates but our most likely is going to be between soil on earth, Agar, and Igneous minerals. This was decided with a decision matrix which you can find at this link:

Ventilation



Humidity for the greenhouse will need to be kept at around 70% humidity.

Growbeds



Water collection system.

plumbing in and out of growbed

If you would like more information on how the plumbing works, use this link:

Bamboo

We have picked 3 types of bamboo, Fargasia Robusta, Dendrocalamus Gigantius, and Bambusa Oldhami for their Structural, C02 removal, and growth time.

NASA HUNCH

Lunar Bamboo Greenhouse

Designed by:

- Ella von Mosch
- Miles Roberts
- Ezra Lifferth

Teacher:

- Renee Chambers

School:

- SMSD Center for Academic Achievement

Contact Us

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Miles Roberts
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Ezra Lifferth
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Renee Chambers
reneechambers@smsd.org

Pictures Throughout the Project

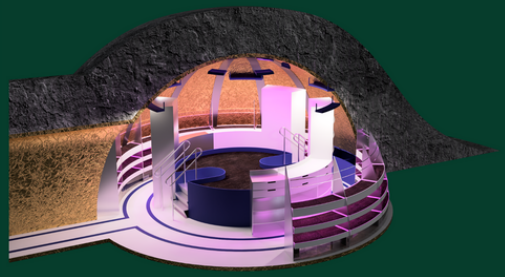
Final Slideshow Presentation

Project Description

Our group was prompted with a problem by NASA HUNCH to design a sustainable habitat on the moon that will house plants and produce natural oxygen as well as remove carbon dioxide. Bamboo has been identified as a highly efficient plant for converting carbon dioxide into oxygen. Therefore it is deemed an ideal plant to grow on the moon. Since transporting anything like soil from Earth to space is remarkably expensive, NASA would like to grow bamboo and other plants in lunar regolith (dirt) to save money.

In addition to designing a lunar habitat, we were asked to grow bamboo in simulant lunar soil, which in our case, turned out to be decomposed granite.

FROM DIGITAL



QR Code: CAD Model Video

TO PHYSICAL

Bamboo Grow Tests

For the testing portion of our project, we grew various bamboo seeds in a lunar soil simulant (decomposed granite) to see which species of bamboo would thrive best in lunar soil. We tested three types of bamboo, *Phyllostachys Heteroclada*, *Phyllostachys Edulis*, and *Dendrocalamus Asper*. We hypothesized either bamboo of the *Phyllostachys* genus would grow the best as that genus is better suited for the habitat conditions (71°F and 40% humidity).

Selling Points

- Customizability
- Multiuse growing beds
- Mesh growing trays
- Express Rack-like design that follows the curve of the dome
- Rail system surrounding the greenhouse for racks and more
- Multi purpose work stations which fit onto the rails and the grow bed.

More Information

FLOWCODE PRIVACY.FLOWCODE.COM

Scan the QR code to see our project and process more in depth!

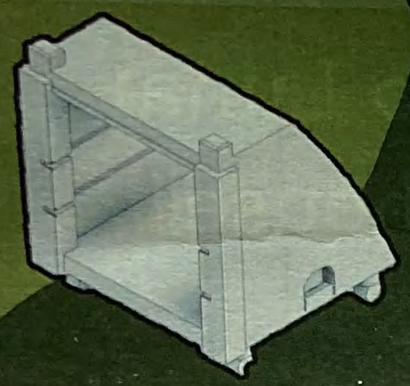
Bamboo Lunar Greenhouse!!

By The Bamboo Guru's

Elijah McCoun
Morgan Watson
Seth Johnson

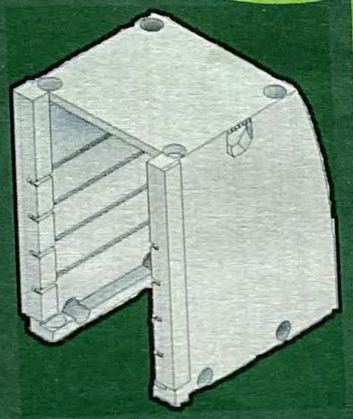
Mr. Anderson
Billings Career Center

Upper



- Wheels that easily fit into the lower part.
- Latches that secure the top to the bottom.
- Heavy wheels to make the upper part be able to move easily on the ground.

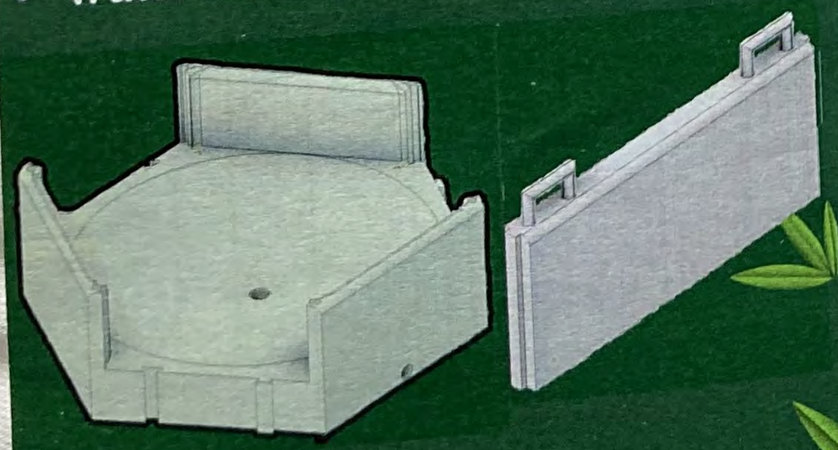
Lower



- Slots for trays to slide in and out with locks keeping them from falling out.
- Holes on the bottom for rails to fit into for easy maneuverability.
- Lower storage area for extra trays and grow bags.

Lunar bamboo grow bed

- Connect more than one grow bed together.
- Along with sliding walls to separate them.
- Water drainage for recycling.



Decision

Using several different decision matrixes we found the most efficient way to solve each problem

Germination Control Matrix

Ideas	Spacing	Cost	Complexity	Size	Total
Express rails	4	2	2	4	12
Center Bed	2	3	3	1	9
Aisle Bed	3	3	4	2	12
	4 3 2 1		Spacing is defined		

Bamboo Matrix

Bamboo

Ideas	Cost	Size	# of uses	Space to grow	Control	Total
Yellow Groove	3	3	4	4	3	17
Chinese Bamboo	3	4	1	4	2	14
Tropical Giant	1	1	2	1	4	9
monstrabe	2	3	3	2	3	13
	4 3 2 1	(40-30)				

Grow Bed

Ideas	Spacability	Convenience	Cost	Performance	Total
A	4 4	4	3	3	18
B	2 2	3	4	2	14
C	3 3	2	2	2	13
D	3 4	3	1	1	12
1	2 1	2	3	3	11
2	3 1	3	4	3	11
3	2 1	2	3	4	12

Lunar Greenhouse Prototype

- Wood base spraypainted white
- 3D printed grow beds located on the center of the room.
- Set of tubes surrounding the room acting as our express rails.
- 3d printed grow bed with an interlocking design to maximize efficiency.
- White tubes inserted into the grow bed acting as our movable grow lights.
- 3d printed work stations that can either interlock into the grow bed or sit on the rails to slide around.

Bamboo

The bamboo chosen for our project was the Yellow Groove Bamboo.

- Running Roots
- Good tasting shoots
- Good O2 production

✦ Problems ✦

- Purifying large quantities of CO_2
- Getting building materials
- Providing a food source to astronauts
- Accomodating many types of plants
- Conserving water

✦ Solutions ✦

- HVAC system and adequate bamboo species
- Appropriate bamboo species and tools to cut it
- Edible bamboo species
- Customizable growth medium
- Good plumbing system

✦ Why It Works ✦

- Our bamboo species have above-average carbon sequestration rates. Our HVAC system allows higher CO_2 levels and better air circulation that increase purification by 40%.
- Our tall growth beds and their support beams accomodate large bamboo plants.
- Our species are edible and high in fiber, a macronutrient astronauts often lack. Our smaller growth beds allow some plants to be grown exclusively for food.
- Our diverse and modular growth bed design accomodates many plants. Our plant cup design allows for plant transportation as needed. Water and nutrient levels are also customizable.
- Our circular system prevents freezing and water stagnation and loss. It also feeds into the ECLS system.

Devante Jones, Hannah Mendoza, Omar Rios

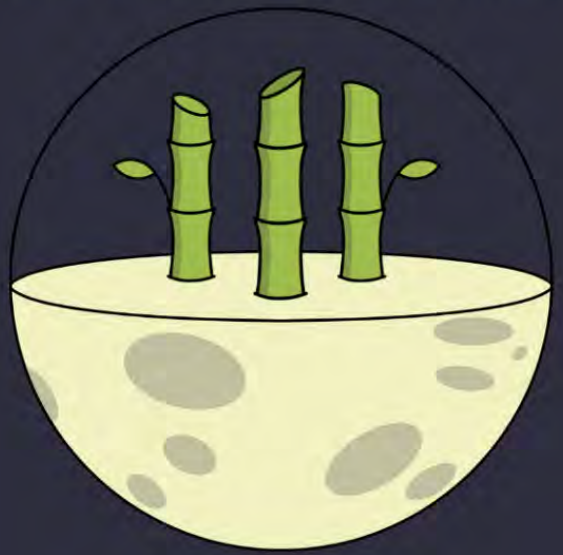
Instructor: **Robert Burke**

School: **Lewisville School of Science and Technology**

Website

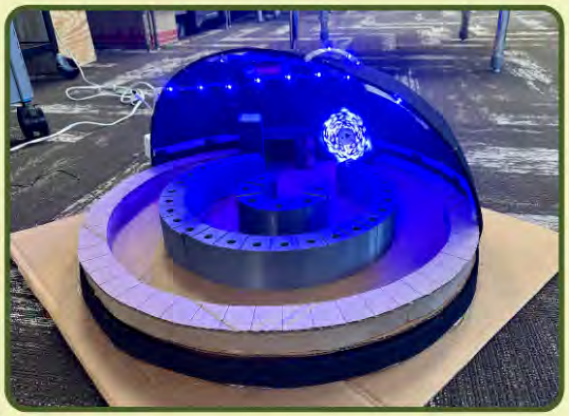
NOVA

New Roots on the Moon



Lunar Bamboo Greenhouse

Current Design



- Differently-sized, modular hydroponics growth beds with support beams. Beams have warped holes for better root grip.
- Structurally sound cup for plants that allows easy transportation
- HVAC system maintains ideal temperature and promotes carbon sequestration
- Circular plumbing system prevents water loss and stagnation. Foam insulation prevents freezing.
- Workspace contains desk, useful tools, and seed incubation chamber
- Accessible, AC electrical system

Growth Experiment

We tested a seed incubation method where we put the seeds in a hydroponic sponge on a tray on top of a heating mat.

- Scarred seeds to get them out of dormancy
- Used the floating seed viability test
- Used pre-boiled water to prevent fungal infections
- 2-3 seeds per sponge
- Two groups, one exposed to light and another in darkness
- Measured temperature and humidity levels

Most seeds were unviable; we suspect they arrived in that state.

- No evidence of growth
- No infections this time
- We think seeds may not be good to transport to space because of long germination rates and unreliable viability

FUTURE TESTING

Pre-grown *Bambusa tuldoides* plant. It has survived thus far.

Next Steps

FUTURE GROWTH PLANS

- Test deep water culture hydroponics
- Grow some culms in soil as the control group
- Monitor temperature and humidity
- Try to propagate plant
- Test plant's response to CO_2 level manipulation

FUTURE DESIGN

- Adjust systems for more space
  - Plumbing system
  - Workspace
  - Growth bed layout
- Resource management specifications
- Develop workspace
  - More tools and functions
  - Better layout

LUNAR OASIS

Scan QR code for an informational video

Project Green Thumb

SUMMARY

Our lunar garden combines aesthetics with efficiency, providing a stress-relieving oasis for lunar inhabitants. In addition to bamboo for food, building materials, and oxygen, we plan to cultivate crops like lettuce, radishes, and carrots, enhancing overall functionality.

HYDROPONICS SYSTEM

Our hydroponics system efficiently grows vegetation in a soiless environment, using only water, hydroponic pebbles, and liquid fertilizers. This eliminates the risk of soil and pest borne diseases, while also being more space efficient and providing the plants with the necessary nutrients.

LIGHTING

Our lighting system utilizes timer controlled artificial grow lights to provide optimal conditions and maximize bamboo growth. It turns on at 8 a.m. and off at 3 p.m. to supply the bamboo with the suggested 7 hours of sunlight.

SCALE MODEL

Our scale model greenhouse incorporates three different levels to allow for underground storage of water, lighting, and ventilation systems. This provides more room for bamboo growth and a larger workspace for the astronauts.

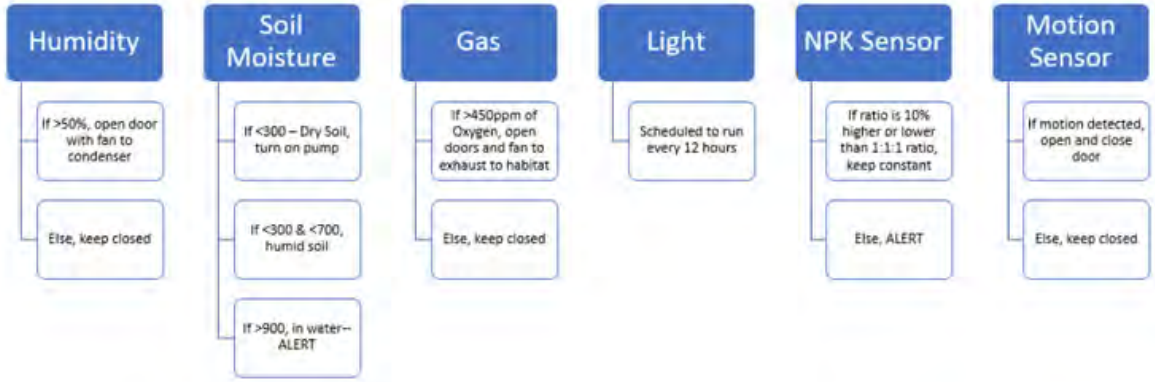
VENTILATION SYSTEM

Our ventilation system will use two fans on opposite sides of the greenhouse along with a dehumidifier to circulate the air and regulate the temperature and humidity

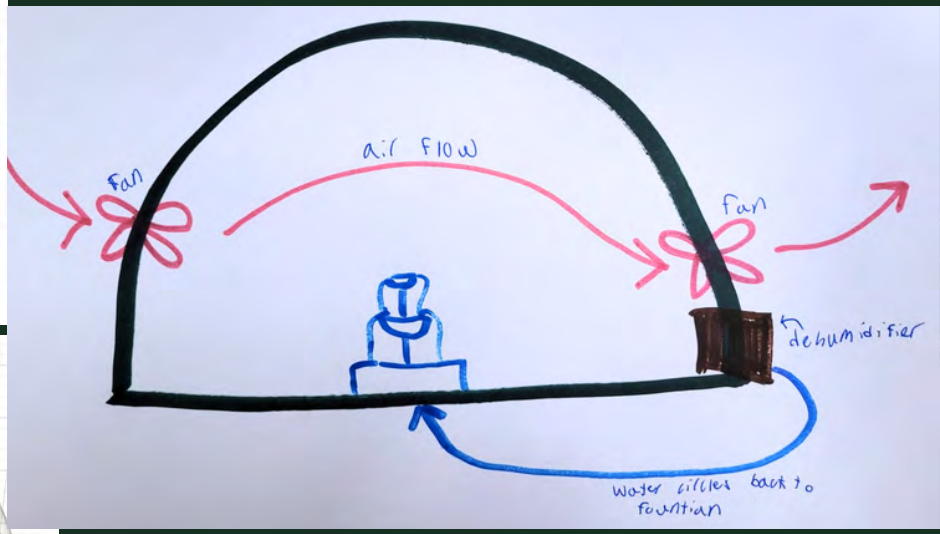
VEGETATION

Our hydroponic system supports growth of chimonobambusa quadrangularis, more commonly known as square bamboo. This bamboo thrives in an environment with moderate temperatures and heavy irrigation, making it ideal for our hydroponic greenhouse. Square bamboo is a species of running bamboo, so using a hydroponic system will effectively contain the roots.

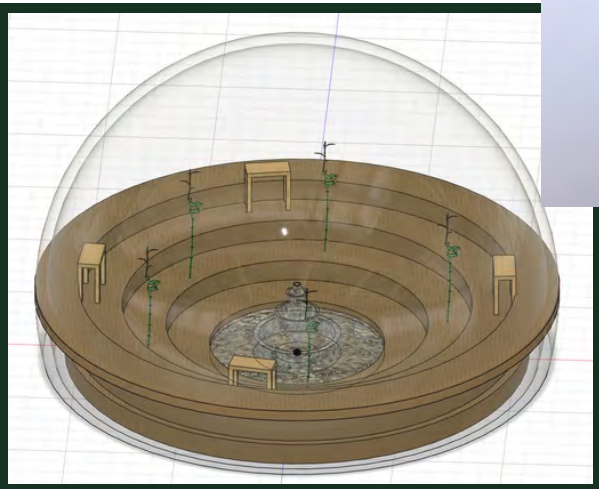
Bamboo Greenhouse Control System

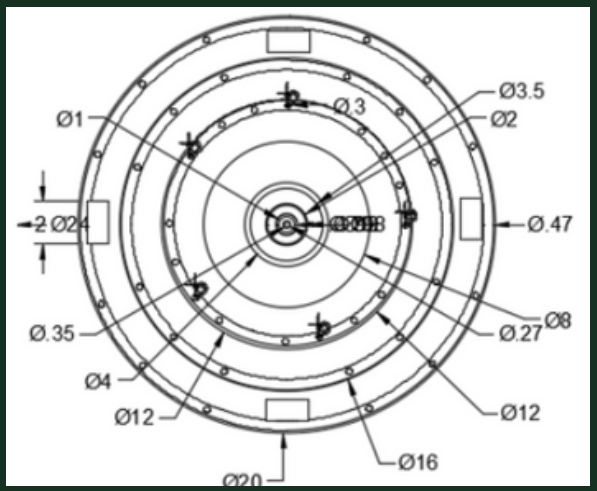


Ventilation and Filter Diagram

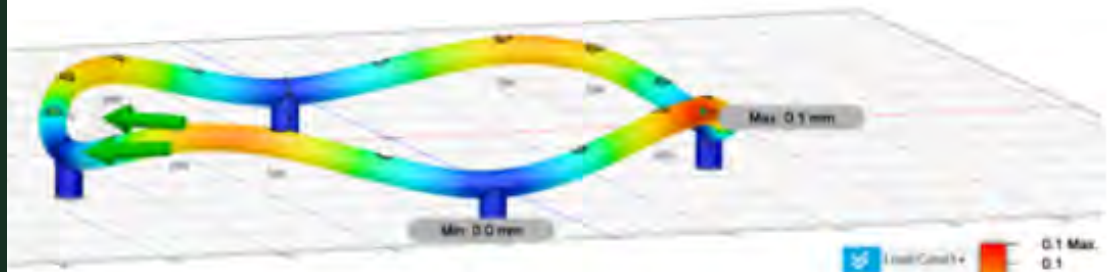


Project Greenthumb Full Dome with Materials and Dimensions





Proposed Material : Polyethylene Chloride, thickness of 0.6inches

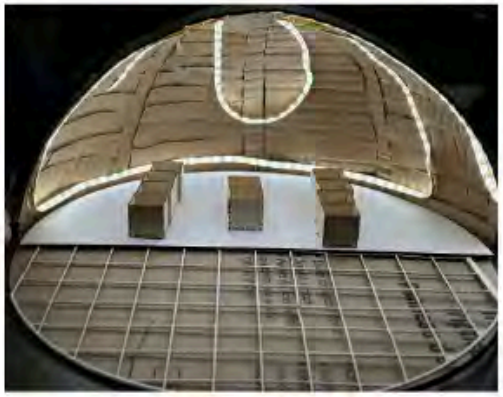


Displacement caused by 4.67 kPa pressure on hydroponics system. Max displacement 0.1mm

Bamboo Boys

Tri-County RVTHS - Franklin MA

Lunar Bamboo Greenhouse



Final Design

Design Highlights

- Fully rearrangeable grow beds layout
- Relaxing/Work area
- CO2 reduction
- No possibilities for trip hazards
- Productive lighting
- Raised floor with all utilities running underneath
- Grid system so you can access all utilities without removing the entire floor for repairs.

Group Members: Cayden Bourassa, Jonah Scott, Aaron Mushlin, Parker Loconto, and Loatchwel Joseph

For more information about the certain areas, scan this code:

Email: tricountynasa@gmail.com

Teacher: Mrs. Magas

Project Requirements

- **Ventilation**
- **Automated Watering**
- **rearrangeable layout**
- **Lighting**
- **walkways and work areas**

Idea Design

Testing

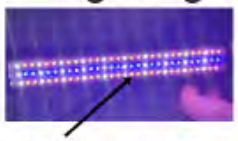
We had a lot of testing with the layout, growbeds, watering, ventilation and lighting of the greenhouse optimal area and growth for the bamboo. With this testing we have found out things that could work and things that couldn't.

Layout

Watering

Grid style layout across roof

Lighting



Full Spectrum Lighting

Substrates and Fertilizer

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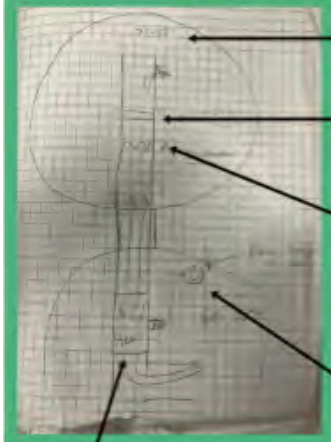
Ventilation



70-80 degrees F

Humidifier

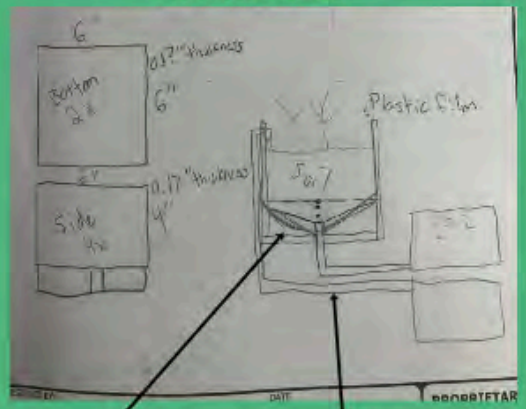
Condenser

Rain Barrel

AC/Heat

Humidity for the greenhouse will need to be kept at around 70% humidity.

Growbeds



Water collection system.

plumbing in and out of growbed

If you would like more information on how the plumbing works, use this link:

Bamboo

Grow Lights

Seedling beds

We have picked 3 types of bamboo, Fargasia Robusta, Dendrocalamus Gigantius, and Bambusa Oldhami for their Structural, C02 removal, and growth time.

Actual Bamboo we got to grow

Seedlings

Problem Statement

Our group was tasked with the creation of a 10” by 20” dome shaped greenhouse, that must be habitable for humans and plants

Our Solution

We are designing a habitat that utilizes the space given to find the best and most efficient way for growing bamboo and other plants, and for movement around the habitat

Power Point Presentation

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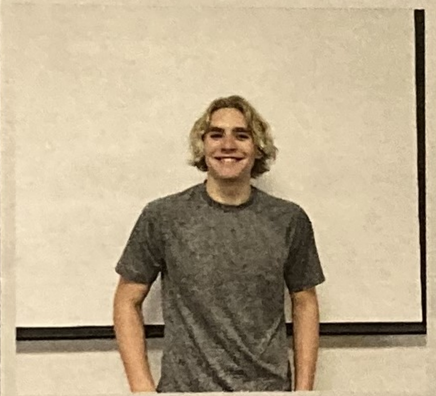

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Lunar Bamboo Greenhouse

Andrew Saad and Olivia Bihm

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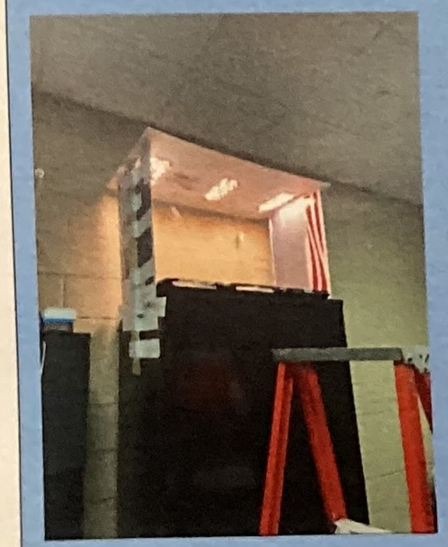
Growing process

We used 3 separate grow beds to house our bamboo and used different ratios of simulated regolith composed of crushed lava rock and sand to earthly soil. The first 3 columns were ¼ regolith. Then the next were ½ regolith, then ¾ , then full regolith. the missing percentages were filled with earth soil. Every four rows were one species of bamboo, making us grow 6 different species of bamboo.

Species we grew

- Costa Rica red
- Black Bamboo
- Sergras bamboo
- Tropical black
- Fargesia bamboo
- Natural bamboo



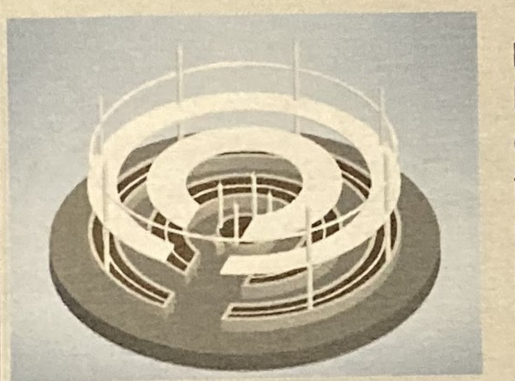
Lighting

We found that utilizing LED grow lights utilizing red and full spectrum color to influence and efficiently grow the bamboo from seeds

Design

Physical Design

Our current design employs a double circular design which we figured would have the best amount of grow space and walking space. We used the middle of the exclusively for growing bamboo since the middle has the most height for the bamboo to grow to. Then the middle we made it to that it can accommodate bamboo or other plants such as vegetables. Finally, the outer ring is reserved for exclusively for growing edible food such as blueberries radishes, and/or carrots.



Mixture of Air

In the upper ring it carries the air to the habitat. At four separate and even intervals, there is a vent to eject the air and circulate it thought the habitat

Lighting

Under the grow bed's roofs, there will be full spectrum grow lights to support the plants growth.
There is rotatable grow lights to compensate to the bamboo's growth

Humidity

There is a humidifier/dehumidifier to control the internal humidity

Hydration system

Our habitat's watering will be though a soaker hose drip type system. The hose will drip water onto plaints in the soil. All unused water will recycle back into the water system.

Growing research

After our successful cultivation of bamboo in multiple types of soil, we decided to have a more diverse plant selection. We moved from just bamboo, to cucumbers, zucchini, and carrots.

- We planted Moso Bamboo on 1/12
- On 1/17 we planted cucumbers, zucchini, and carrots, then they sprouted 5 days later on 1/23 the cucumbers, zucchini and carrots sprouted
- On 1/29 we planted more bamboo, giant bamboo and Japanese timber bamboo.
- On 1/31 we transferred the best sprouts of cucumber, zucchini and carrots into a bigger growing environment.

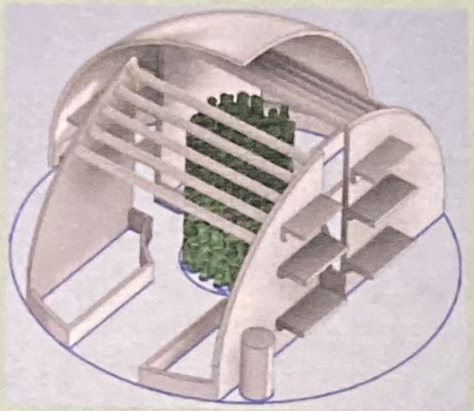
These are our first sprouts of carrots on 1/23

The cucumbers and zucchinis before transplanting 1/29

The aftermath of moving the cucumbers/zucchinis to bigger cups 1/31

The carrots before transplanting 1/29

Habitat Designs



Our original habitat design had our bamboo growing in the center with a curtain surrounding it along with 4 growing beds at ground level. We created lighting rods across the top of the ceiling. We then made two separate rooms that would isolate humidity levels along with shelving and water storage units on both sides. Our primary flaw with this design was the two pod walls, so when revising our design, we chose to create simpler ways to divide the space without having a lot of weight relying on the walls.

Our final habitat design kept our growing bed in the center with the curtain. We kept the 4 growing beds surrounding and made changes to their shapes to add water storage. we also modified the way we wanted to store the water. By creating a better storage container, we downsized to only having one pod on the side where inside we created a riser system to house different trays of plants. We added adjustable vents to control the humidity in the pod. We created a door to our pod to trap more humidity in it if needed. We added clip on lights to our risers so the lighting can be specific for each plant growing in the pod. For the other lighting outside the dome, we created adjustable light panels that go over our 4 surrounding growing beds. On the other side adjacent from our dome, we created another riser system for storage of watering cans, pots and our clip lights and any other materials needed to be stored. we added 2 growing beds one in the back by the water storage and one next to our riser storage that don't have any direct lighting on it for plants that done need direct light to grow. Throughout the design we created many adjustable factors since plant growth is undeterminable.

Our Team

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Problem statement

-Can bamboo be used to remove carbon dioxide from the air, supply oxygen and be a structural material on the moon?

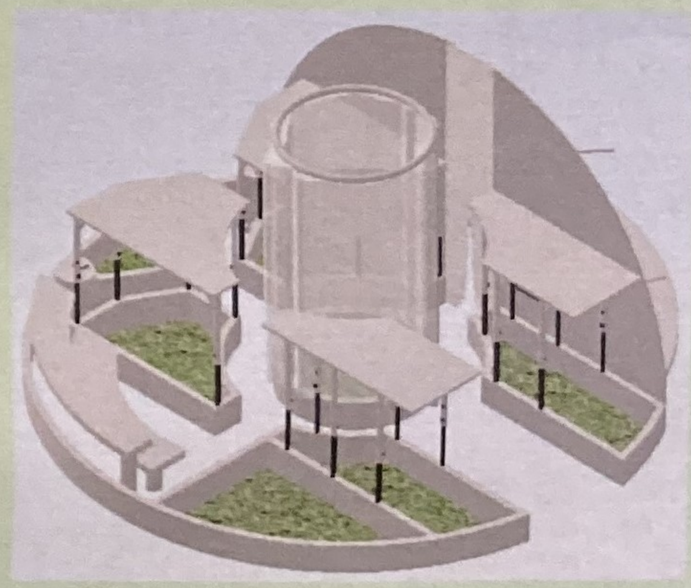
-What would the greenhouse look like when built for the moon?

LINK TO OUR POWERPOINT

Lunar Bamboo Greenhouse

By: Lauren Humble &

Madison Stilley Howard



Mr. Merritt

Clear creek high school

Planting Process

One main question we wanted to answer was how much soil needed to be brought to the moon, so we ran tests which included different mixtures of soil and lunar regolith simulant. We did this process throughout all three experiments. We also did research on lighting options for us to use to compare colors, wattages, and heights. After our research we landed on three red-full spectrum 20-watt lights that emit wave lengths of 660nm 630nm and we then set up a greenhouse that accommodated for all these aspects. We made the lights evenly spaced out 18 inches above our plants, so the light was arranged evenly.



All of us working on the planting process


Our earth habitat with our humidity domes and our lighting.

Growth Experiment 2

In this experiment, we are growing Moso, Giant timber & Japanese giant timber bamboo. We also planted carrots, cucumbers, and zucchini. We are testing other vegetables to see if astronauts could grow and eat fresh vegetables and find more scientific research regarding plant growth with lunar regolith.

January 12th planted moso bamboo.

January 17th planted carrots, zucchini & cucumbers.

January 23rd Sprouted carrots, zucchini & cucumbers

January 29th planted giant and Japanese bamboo

January 31st replanted carrots, zucchini & cucumbers




Growth Experiment 3

We knew carrots and cucumbers could grow in any soil mixture, but they very quickly outgrew the environment they were in so in our third and last experiment, we started our seeds off in a bigger pot keeping up with the soil ratios. We discovered yet again that cucumbers and carrots can sprout in anything. We also had some left over giant and Japanese bamboo, so we wanted to test to see if a bigger growing environment was betters suited for our bamboo.

Growth Experiment 1

In our first experiment, we planted six different Bamboo species to see which one grew the best with different environmental aspects. We were able to have 4 bamboo seeds sprout, they only lasted about a month before they died. We learned a lot during this experiment over the course of 3 months. Discovering how long it takes for bamboo to grow, leaf burn and other aspects we did not consider.

11/1
costa Rica red
¾ regolith

11/2 seirgras
¾ regolith

11/6
costa Rica red
¾ regolith

11/6 fargesia
¾ regolith


11/10 costa rica red
¾ regolith


11/10
seirgras
¾ regolith


11/10
fargesia
¾ regolith


11/10
fargesia
½ regolith

12/1/23

Costa rica red
¾ regolith

Fargesia
¾ regolith

Fargesia
½ regolith

September 29th. we planted.

October 5th our earth greenhouse was complete.

November 1st start of our growth

November 22nd replanted the bamboo into bigger pots.

December 22nd our bamboo died