2022 Design and Prototype Finalists

Crystal Growth NanoLab

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Teacher: Sandra George
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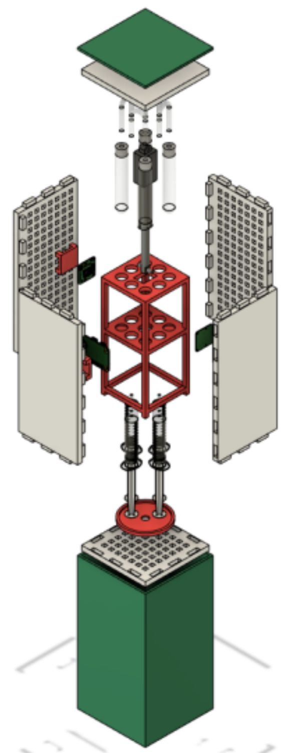
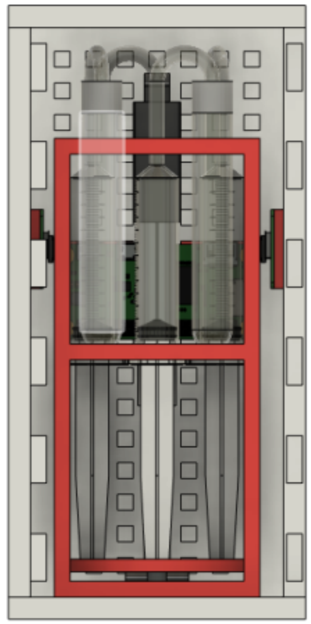
Students: Ayden Allen, Jorge Tijerina
Teacher: Robin Merritt
School: Clear Creek, Texas

Students: Kaylee McDowell, Leneth Veit, Laila Craig
Teacher: Louis Reyes
School: Space Coast Jr/Sr, Florida

Students: Nicole Garcia, Aidan Baxter
Teacher: Jarrell Ford
School: Cypress Woods, Texas





ABOUT

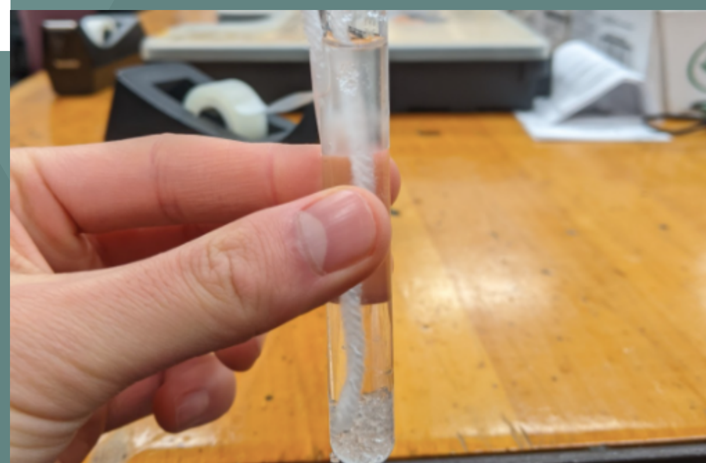
OUR PROJECT

We are developing a generic Nanolab for crystal growth experiments on the ISS since crystals in space grow with fewer impurities. These crystals can can be used to advance the development of drugs, electronics, and metals. Our biggest goal as a group is to make the Nanolab versatile for researchers.

CRYSTAL

EXPERIMENTS

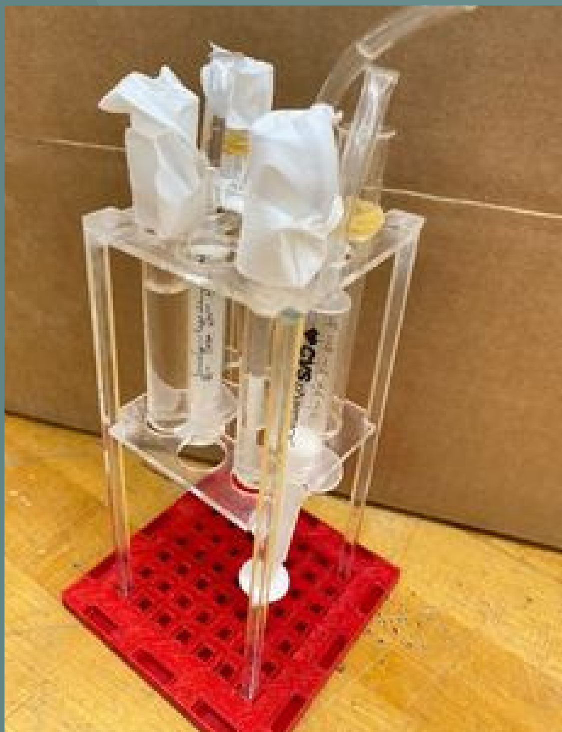
We used alum to mimic the crystals we will grow on the ISS. The crystals pictured below were grown in under a week using the methods of supersaturation and crystal seeding.



GLENELG CRYSTAL NANOLAB

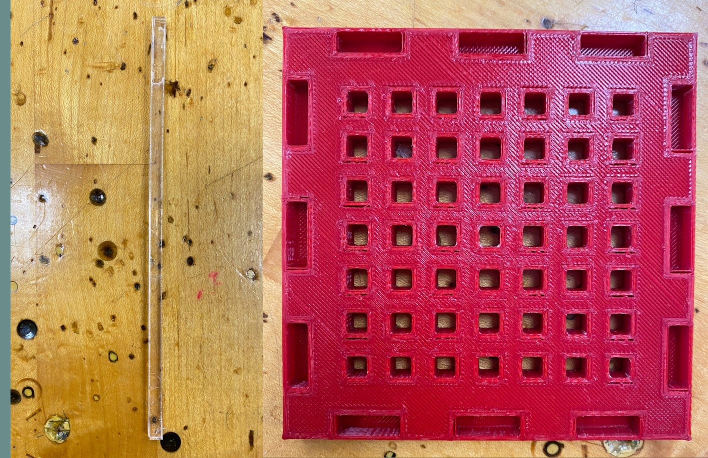
Daniel Chen
Avishi Garg
Jacob Lee
Teacher:Mr.Gerstner

SYRINGE
EXPERIMENTS



KEY FINDINGS

1. Syringes do not leak liquid
2. GORE-TEX fabric on top of test tubes allows for evaporation but does not allow liquid to escape
3. GORE-TEX fabric stops crystals from growing outside of the test tube



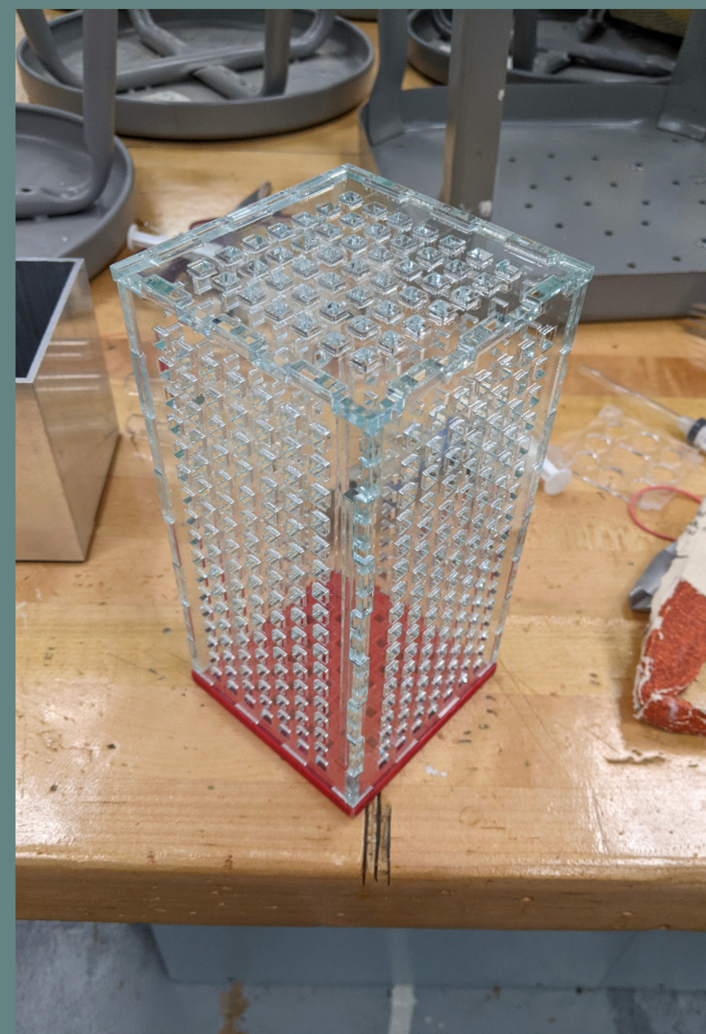
The pictures above display attempts of laser-cutting and 3D-printing parts of our design.

MEETING
CRITERIA

- Our design is compatible with numerous crystal growth methods as it has syringes and test tubes
- The sensor modules which surround the sides of the lab make it versatile as sensors can be placed where the researcher wants them
- Sides of the test tube will be coated with hydrophobic spray to eliminate the risk of water accumulation on the sides

PROTOTYPE
DESIGN

Our prototype features sensor boards on all sides of the Nanolab allowing researchers to have the freedom to place sensors where they want.

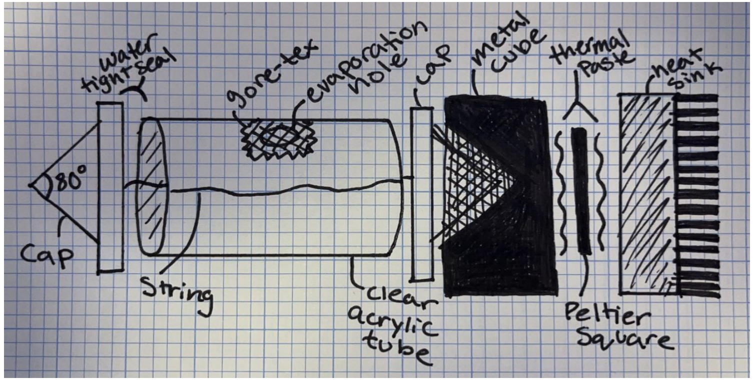


Crystal Growth Nano Lab

Billings Career Center

Mr. Anderson

Eleanor Martin (middle), Ayden Ingraham (right), Zachary Conrad (left)



Below is our prototype design. The arrangement of the cap, block, peltier square, and heatsink will be on both sides of the growth chamber.

Using the Don Pettit wetting angle (80°) will allow the liquid collect in the point of each end of the container. Having a string attached to each point will have something for the crystals to grow off of. The tube portion of the container will be clear (we used acrylic plastic) so a camera can capture the crystal growth.

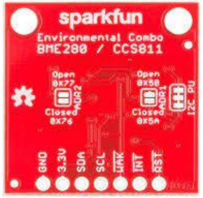
Mechanics: We will have a peltier square connected to a conductive metal block, situated on both sides of our container. This will allow for heating and cooling options of the solution. The container will have holes for evaporation, covered by gore-tex material (we used teflon tape for our experiments) and an absorbing material over the holes. For positioning of each component, we will have a peg-board box.

Video link:

https://youtu.be/ayqwBAj0Pfg

GUI Graphical User Interface

Dan Luba   Radi Irman
Mrs.George
Frontier High School



- Created a Graphic User Interface using python tkinter that interacts with the environment using sensors to give data and to display information to the user
- We were provided the sensors and raspberry pi by HUNCH.
- Github and the official Sparkfun Tutorials were used to get the sensor working
- Modified the raspberry pi settings to enable I2C overclocking to get the sensors to work.
- There is a possibility of the Raspberry Pi overheating and may cause damage to the project. Installed a failsafe to shut-off or reboot if certain temperature is reached.
- Auto and remote start capabilities
- Hardware & Buttons (Some coded)
  - Crystal Growth Lab - Unit Heater (USB)
  - 2 Motors
  - QUIC Distance Sensor - VCNL 4040
  - QUIC Environmental Combo - BME280/CCS881
  - RGB LED Light
  - Pi Camera


Transport
Prototype 1
CRYSTAL
GROWTH
LAB
PROBLEM STATEMENT
WRITE-UP
FINAL PROTOTYPE
SUPPLIES

Premise

The crystal growth Nano-Lab is designed to be a compact crystal growth experiment that will be brought aboard the ISS. This lab incorporates 2 different methods of crystal growth, to ensure that crystals will grow efficiently in their given environment. This lab does not involve any complex electrical or mechanical systems, to maximize simplicity. The lab consists of; a container containing calcium chloride (a strong desiccant that absorbs moisture), a container (coated in a hydrophobic material to contain the solution in a zero-g environment) containing a solution, and a wick running between both containers to help transfer and evaporate the liquid. Once the liquid is absorbed, the solute will begin to crystalize.

CLEAR CREEK HIGH SCHOOL

LEAGUE CITY, TEXAS

PERIOD 4

AYDEN ALLEN, JORGE TIJERINA

MR. MERRITT

CLEAR CREEK

CRYSTAL GROWTH NANO-LAB

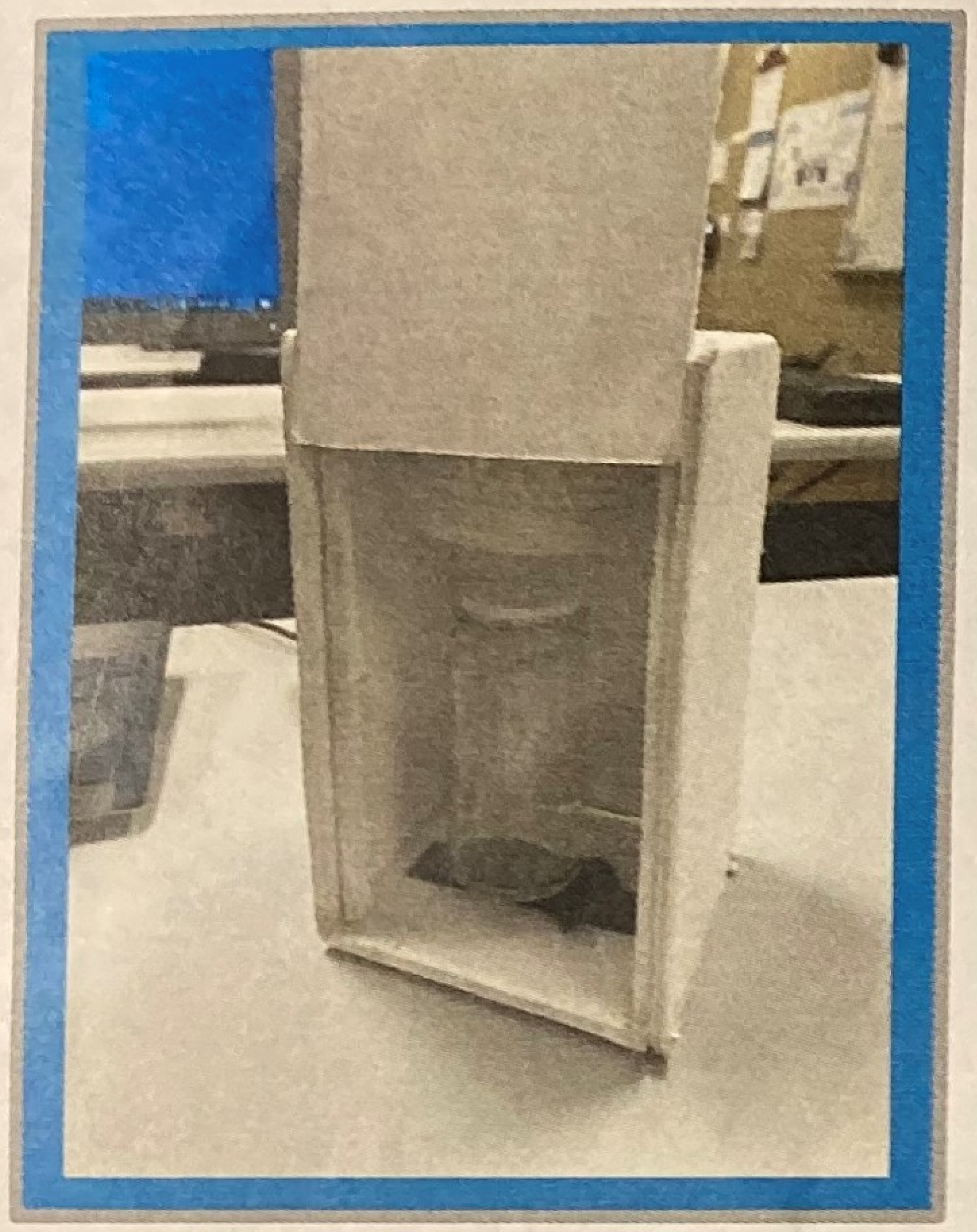
NASA HUNCH

By: Ayden Allen, Jorge Tijerina

Mr. Merritt

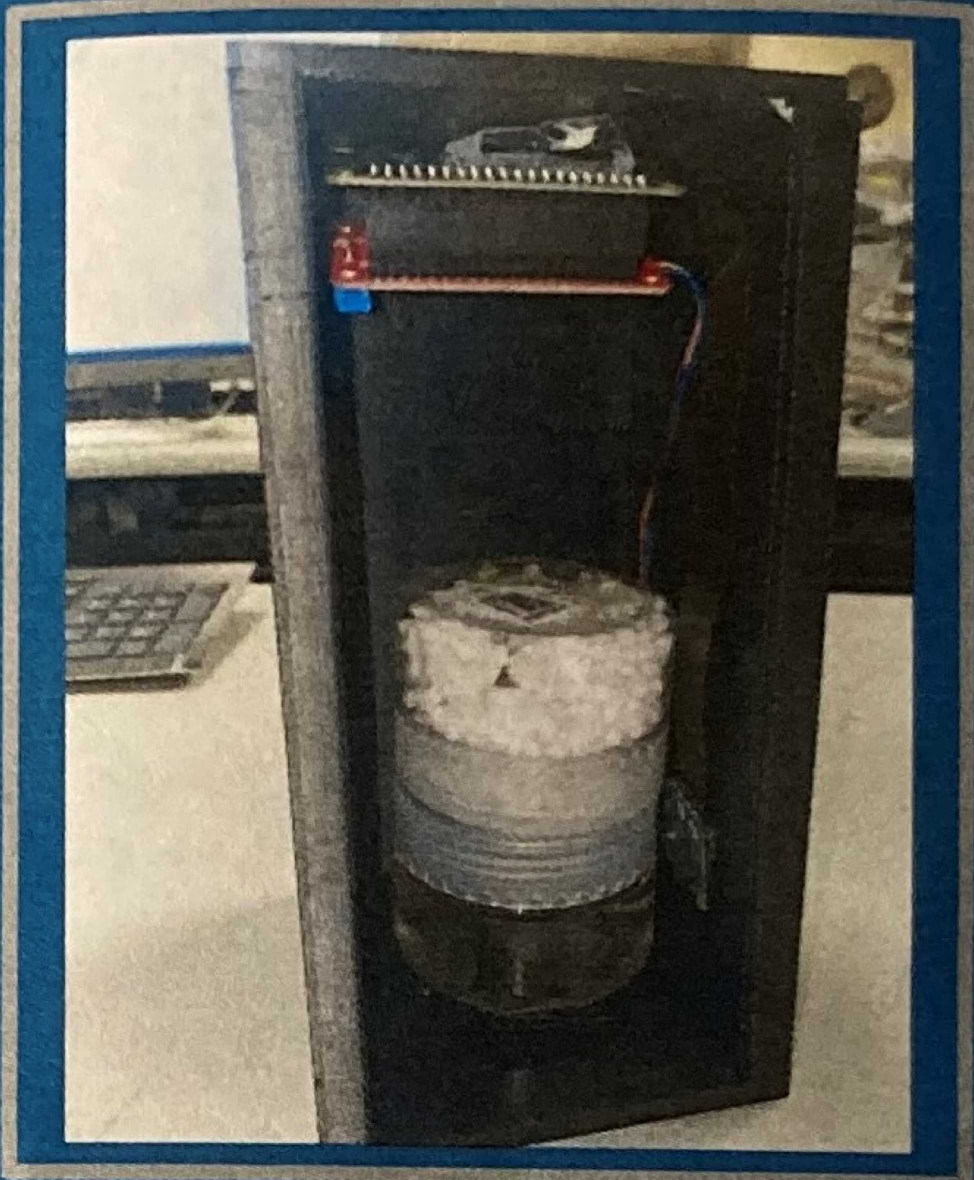
Architectural and civil engineering

INITIAL PROTOTYPE



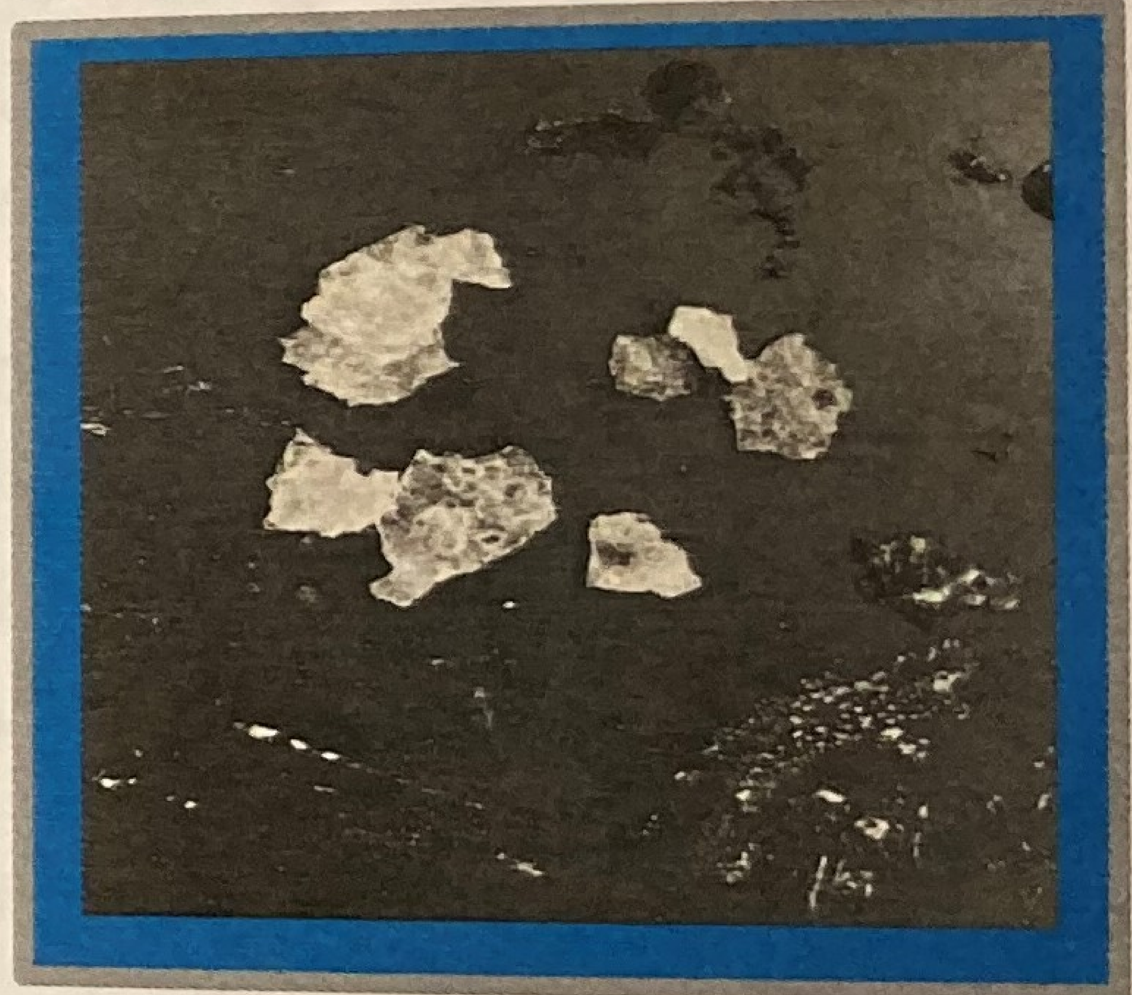
Our first prototype was constructed with high strength foam and was put together using hot glue. We then placed one glass container, containing our solution, at the base of the box, and a plastic container, containing our desiccant, hanging from the top of our box with velcro. After verious test trials, we found that Velco was not strong enough to hold the container with the desiccant, so we decided to make the solution container smaller and stack both containers, allowing the weight to rest on the base of the box.

FINAL PROTOTYPE



The final version of our Nano-Lab was desinged using Autodesk Inventor, and was 3D printed. The Nano-Lab measures 20cm in height, 10cm in width, 10cm in length, and 10cm cm in depth. The 2 containers were stacked on top of one another so that the desiccant would absorb the liquid from the solution better, and to make room for the camera's electronics. The solution's container is coated in a hydrophobic material to prevent the liquid form floating out through the holes of the container in a zero gravity environment. The hydrophobic material will cause the liquid to bead up on the inside of the lid, but will not completely prevent the liquid from escaping. The calcuim chloride will absorb the moisture of the solution through the airways between both containers. A wick made from cotton runs between both containers in will help move liquid to the calcuim chloride through capillary action. As the liquid is absorbed, the solute will begin form in solid pieces and will grow on the edges of the solution container. The Nano-Lab box is equippied with an acrylic sliding face to easily observe the expirement as it takes place.

RESULTS

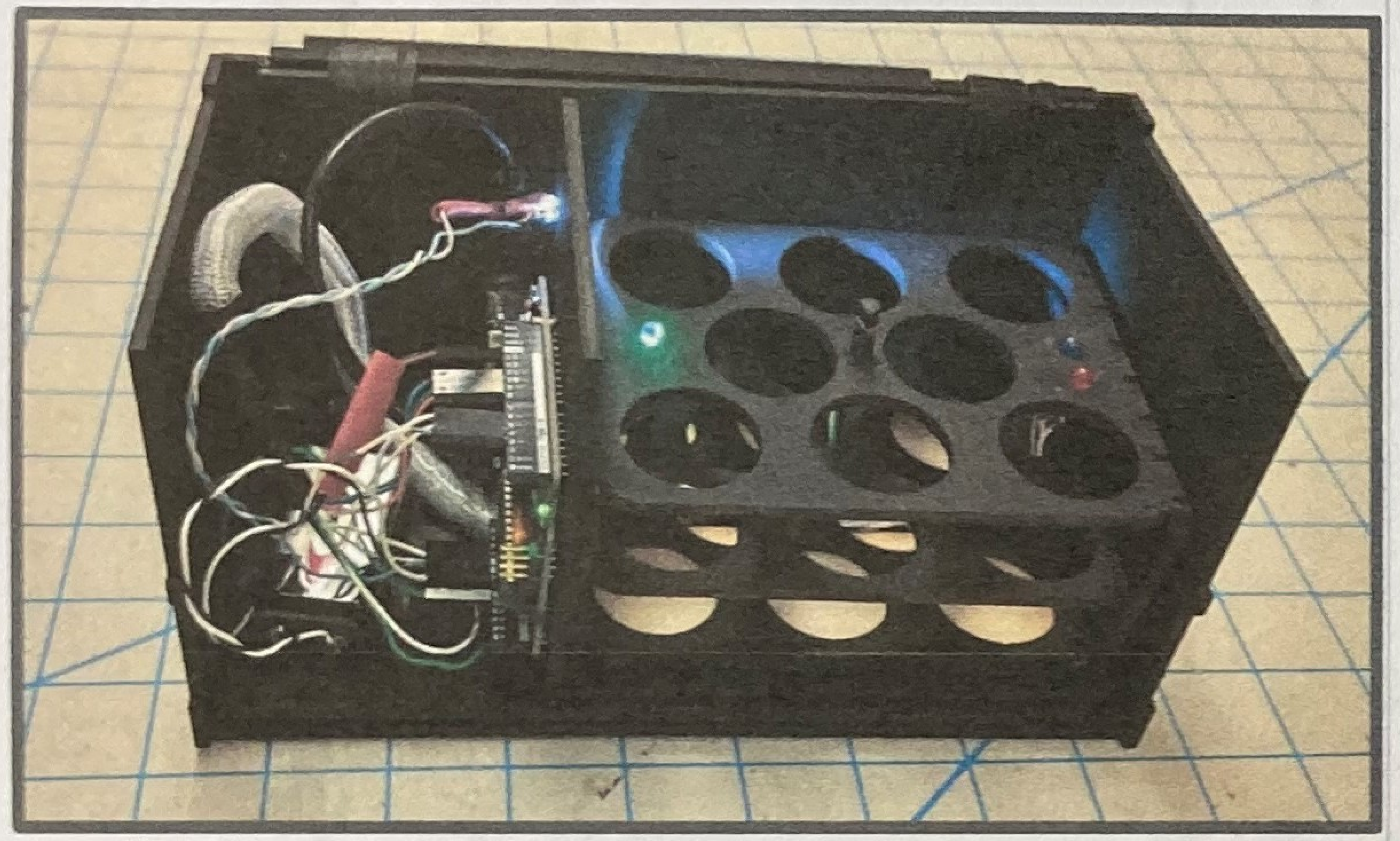


After running a series if experiments with a similar setup to our Nano-Lab, we found that it does take sometime for the water to be absorbed but, the crystals will form better over time. After one week, the smaller sugar cystals formed on the inside of the container. After a week and 4 days, the larger crysals formed around the inside of the enitre container, and over the surface of the remaining water. After each day the solution became very thick, showing that the desiccant absorbed the solution well.


Crystal Growth Nanolab
Space Coast Jr/sr high
Mr. Reyes
Kaylee McDowell,
Leneth Veit, Laila Craig
Detailed documentation was taken weekly recording the changes in the design and development. The original idea was to have a file cabinet design, making it easy for scientists to open and close the lab. Later we came to understand that the astronauts were not going to be touching the lab and the current design was taking up too much space. So we modified and
The specification of the crystal growth Nanolab prototype is 10cm x 10cm x 20cm cube. The procedures of making the design was trial and error and we met most of the set requirements except one. The nanolab meets most of the set requirements, securely able to hold the crystals, maintain the biosphere needed and function independently.
Description and process
The prototype is a self-contained unit and its main function is through the adreno processing unit which controls the hardware. The thermometer controls the heating and cooling of the device. Lights represent the heating (red) and cooling (blue) conditions of the environment. Another sensor includes a status light
developed the design seen today. The completed model will hold the testing tubes securely and be coded in a hydrophobic layer making it waterproof on the inside. The outside will be constructed of aluminum to keep the mass down. All components were laser printed and pieced together. The prototype is a unique design, allowing adequate space for all required components.
The outside will be constructed of aluminum(Alloy 2618) to keep the mass down. All components were laser printed and pieced together. The prototype is a unique design, allowing adequate space for all required components.
which flashes green for the optimal growing environment and red if there is an issue. Using TinkerCad to write the code it is set to have the heater turn on when it gets below a certain temperature, and the chiller turns on if the heater reaches unsafe temperatures. The thermometer controls all the elements of the nanolab all while the camera watches over record data. All the specifications are saved in the SolidWorks file.
First model
Second model
Third model
We were mindful of the launch and microgravity environment while designing the lab and secured all parts to ensure no movement. Shake tests were conducted to guarantee movement does not occur and the payload is safe. The lab will be screwed together and once closed it will not open until it returns to Earth.
3D model First design
Second and final design
Testing
Group photo
STEAM
ACADEMY
HUNCH Design and Prototype Rubric 2020-2021

Crystal Growth NanoLab

Space Coast Sr/Jr High school
By: Kaylee McDowell, Laila Craig, and Leneth Veit

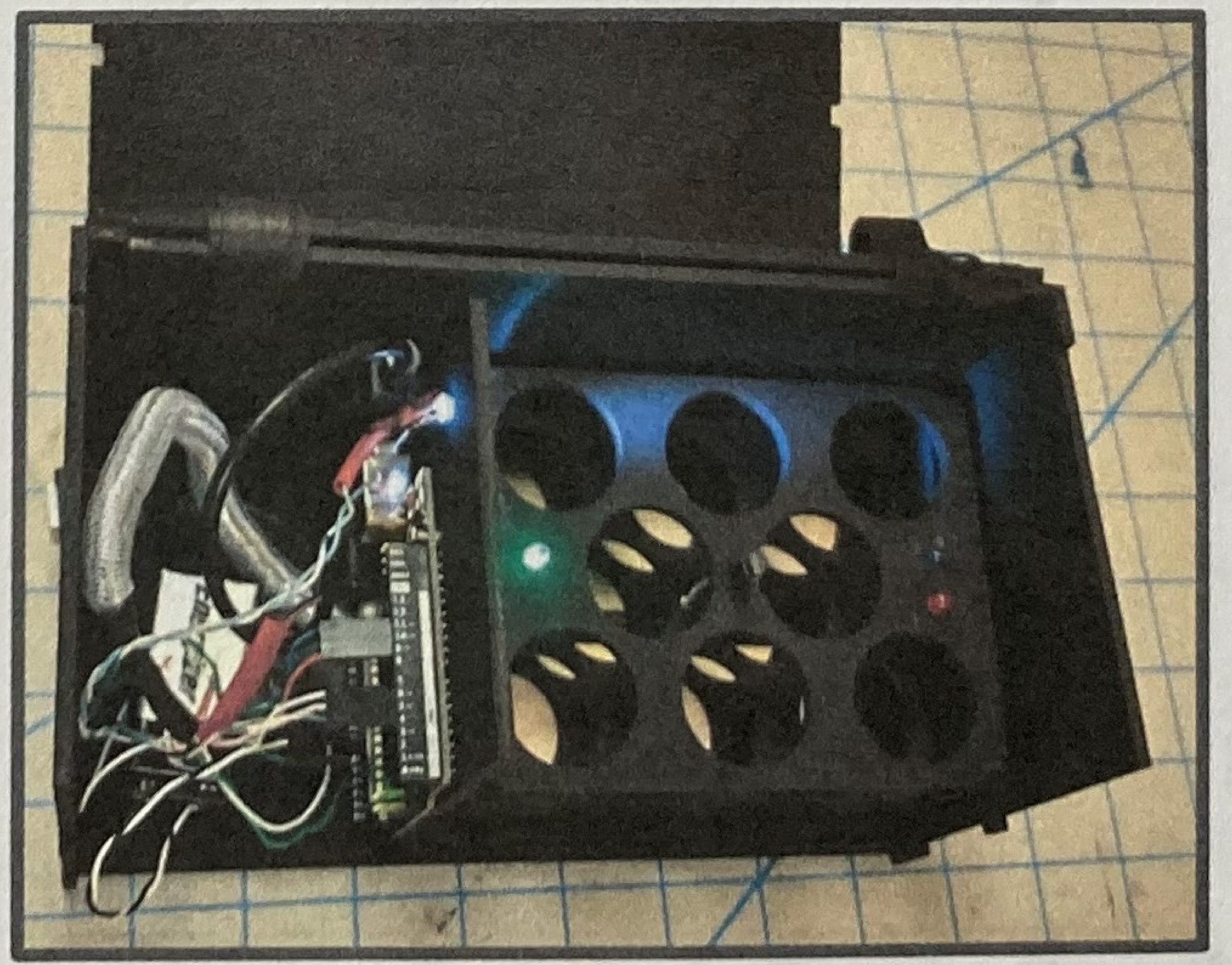


NASA tasked us to construct a lab that was 10cm x 10cm x 20cm, could grow crystals from scratch and included the technology needed to support the task. Lights indicate when the heating and cooling technology is active. Allowing the lab to maintain the environment needed to construct a crystal. A small space was added for the camera to record data. The lab is a plug-in-play model allowing for more than one power source, so it is not a drain of the USB power grid.

Operations and Limitations

The lab is constructed to securely hold the necessary materials needed to grow crystals. While writing the code we ran series of tests to ensure the successful operation of the hardware. The code controls the hardware inside and displays the status of the heating and cooling system.. The light flashes color: blue (cooling), green (good), or red (heater).

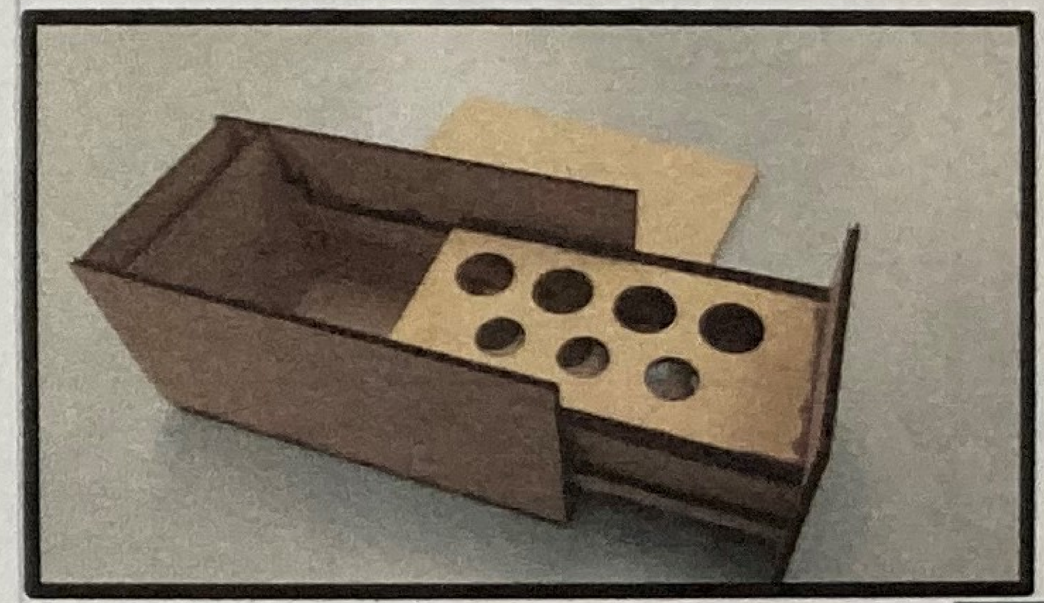
After testing was completed we discovered another obstacle. Crystals need humidity and heat to grow, but the water vapor from this process has nowhere to go. We are still brainstorming ideas to overcome this obstacle, but are confident to discover a solution.

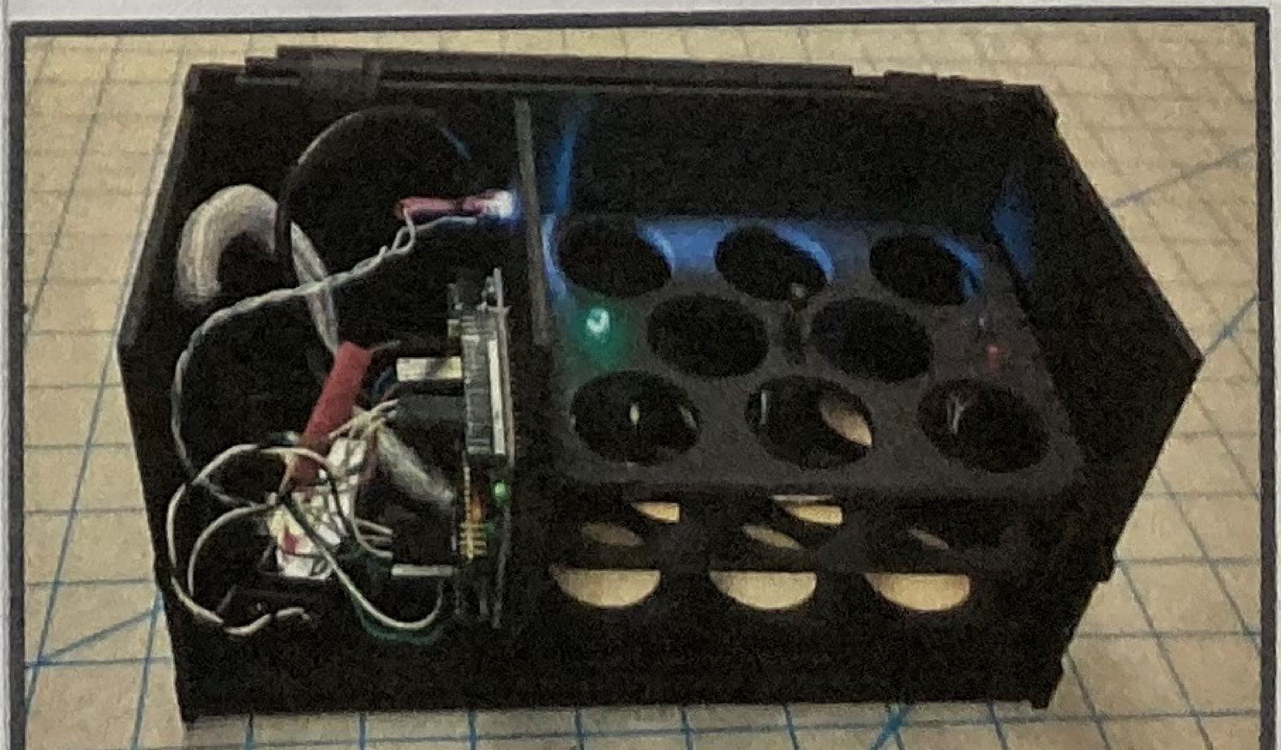


Holy Cow! It works!

Testing the final code, everything worked according to plan.

Picture of our group and Obsidian

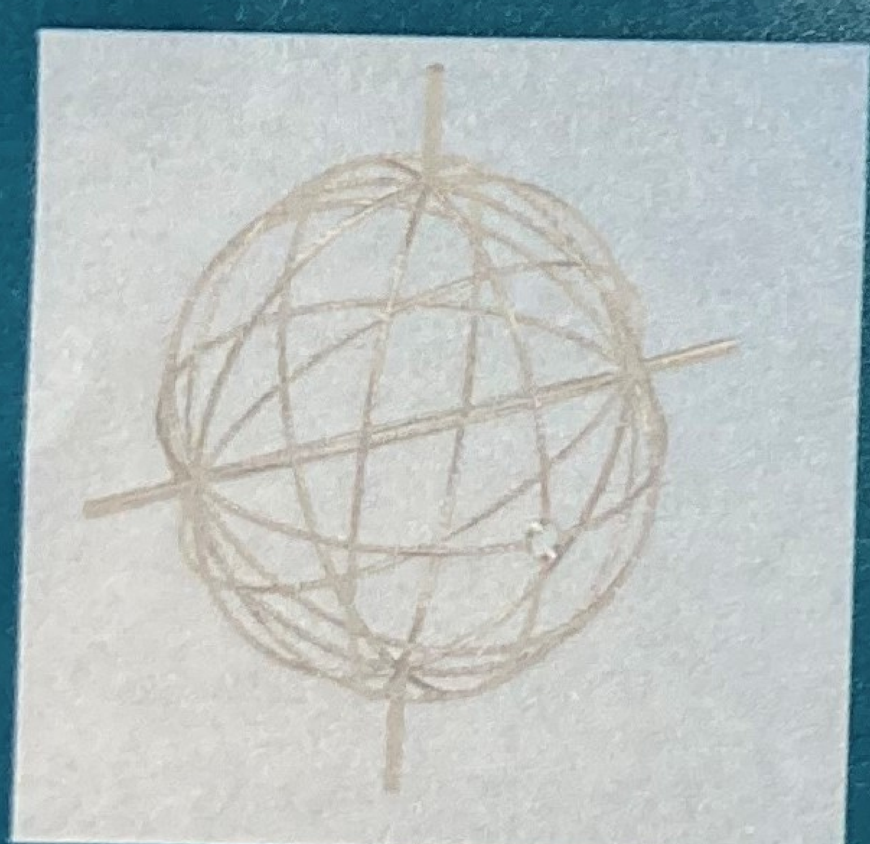





Crystal NanoLab
Cypress Woods High School
STATION

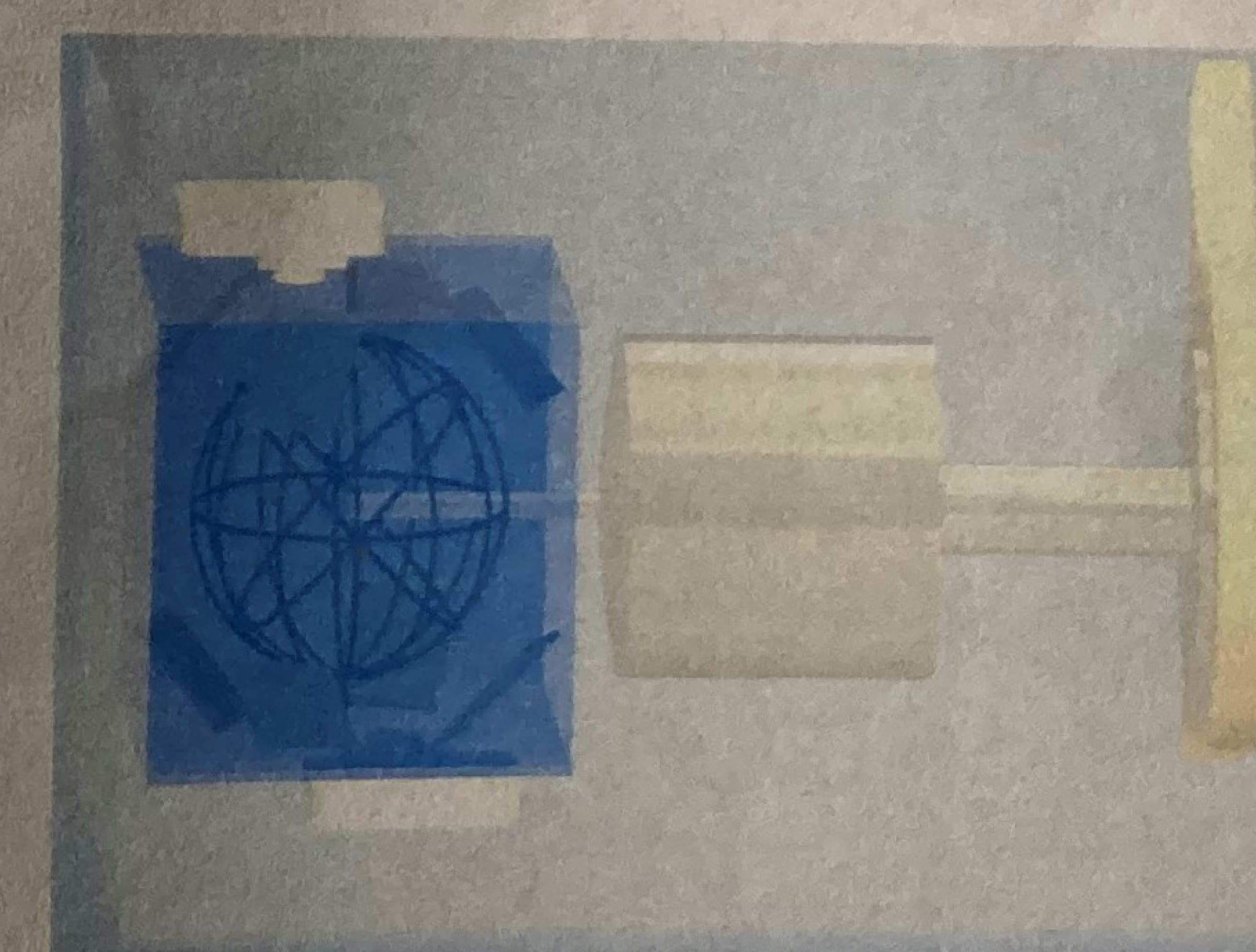
Our current method

We are using evaporation of a solvent which is to dissolve a material like sugar or salt into water and then allow the water to evaporate and leave the salt or sugar crystals to grow. The longer the water takes to evaporate, the bigger the crystals may become.

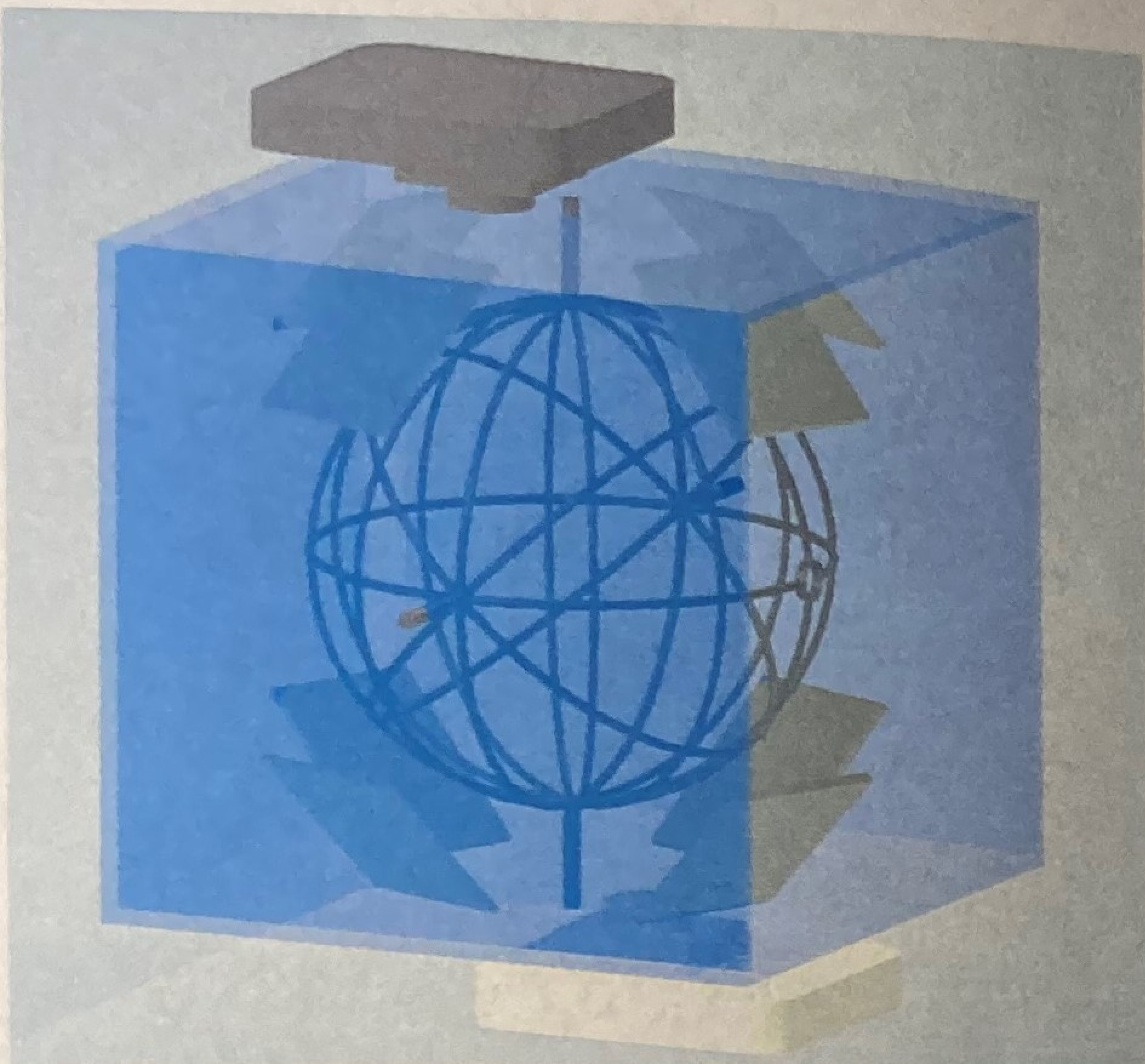


CRYSTAL NANOLAB

Goal: To create a nano lab that functions in zero-gravity and creates the most perfect crystals possible (crystals interact with other objects in the least possible amount). The ideal nano lab should be compatible with many different types of crystallization methods.



BY: Nicole Garcia, Aidan Baxter

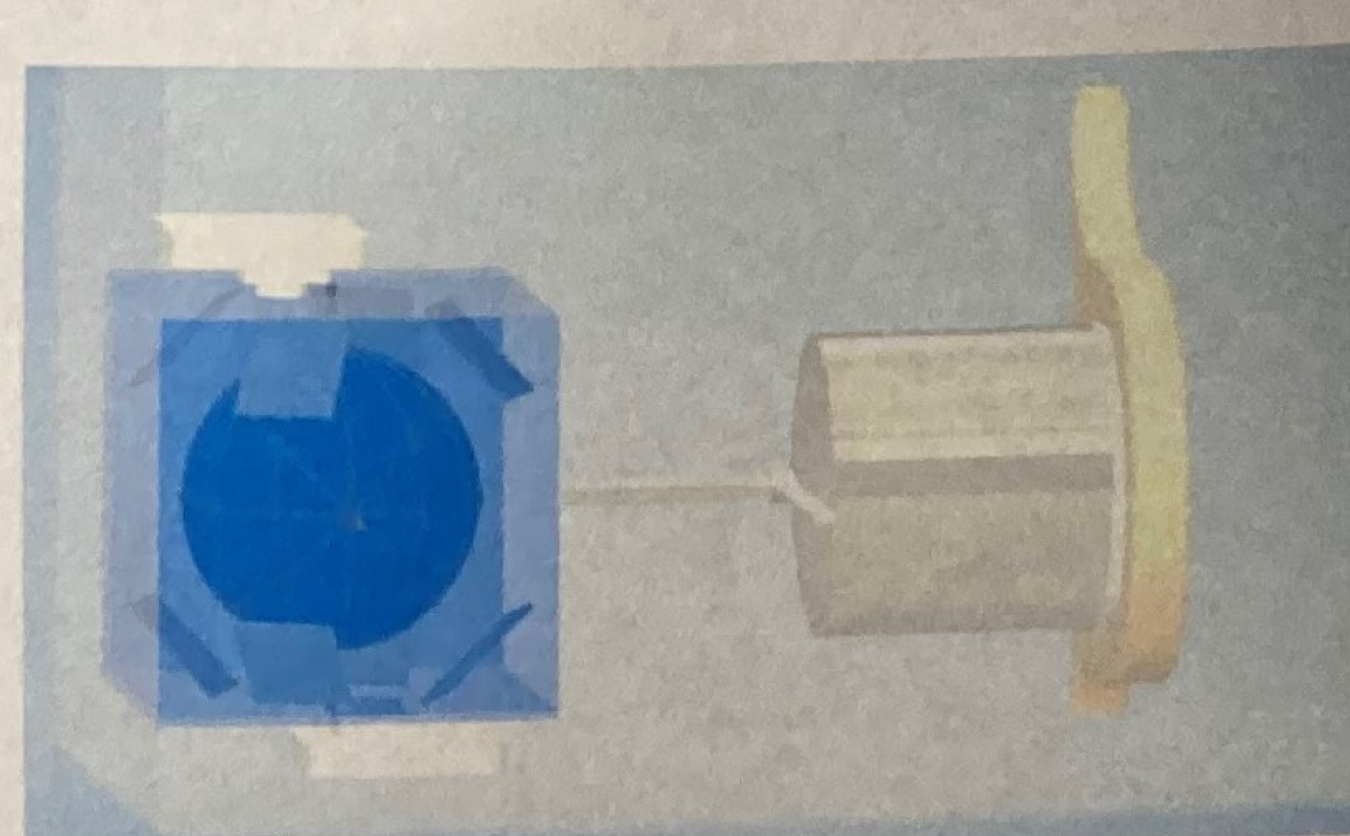


How we'll observe the crystals:

The camera and mirror system: the cameras allow for easy observation of the crystals growing within the wireframe, the mirrors improve the field of view for both cameras for easier observation. For the top camera, the mirrors allow the observer to see the bottom of the crystals, whilst the mirrors allow the bottom camera to see the top of the crystals.

Current design

- The Spherical Wireframe: Solution is applied to the middle and syringe is simultaneously pulled out of the wireframe to avoid water molecules adhering to the syringe. Solution is contained by hydrophobic substances applied to inner portion of wireframe.
    - Pros: No interaction/influence from wireframe onto growth of crystals except for the outer layer, larger heating surface, containment of solution is possible
    - Cons: harder to observe with camera, harder to apply the solution to the inside



Other methods

Cooling from a solid state:

There are a few elements and metal alloys that melt at low temperatures (less than 200 C, some less than 100C) and when allowed to cool slowly in zero-g may form metallic crystals that are different from what would be made on Earth. Studying metallic crystals that form by cooling could be valuable for understanding crystal formation in other metals or compounds. The metals/materials that we found that could work are salt, sugar, quartz, and gallium.

Precipitate reaction:

Precipitation is the process of generating solid from the solution caused by supersaturation when the concentration of the solute is higher than its solubility. This term is usually interchangeable with "crystallization", but differs in that it can also indicate the formation of amorphous (non-crystalline) solid.