Purpose of the Insect Nanolab

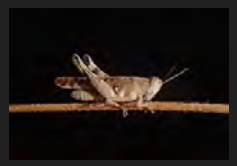
NASA and other researchers are interested in watching the lifecycle, behaviors and effects of radiation on insects living in a microgravity environment.

One of the main benefits of studying insects in space is to determine if they can be a viable food source for astronauts.

Since crickets are incredible nutritious, they are the insect we choose to research and highlight in this investigation. Although, the Insect Nanolab could be used and adapted for any type of insect.

Why Crickets?

- High in Protein - 55 - 73%
- High in lipids ~ 30 %
- 90 day lifespan but can be harvested in 45 days.
- Cricket Protein Powder can be used in a variety of recipes
- All of the cricket can be harvested - no waste



Meet The Team

Lillie Bogdan
Grade 10

Daniel Luba
Grade 11

Maddie Osborne
Grade 10

Julia Tufan
Grade 11

Sandra George - Teacher Mentor
Frontier Central School District

Insect NanoLab

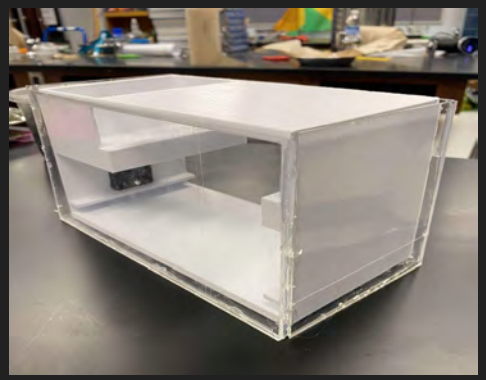
Lillie Bogdan Daniel Luba,
Maddie Osborne Julia Tufan

Frontier High School

Insects in Space

A NanoLab designed to monitor and study the effects of microgravity on the life cycle of Insects

3D Printed Design

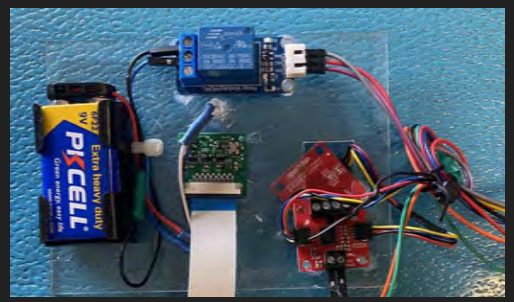


Holds the Raspberry Pi, Camera, 2 LED Lights, Environmental Control Sensor , Battery, Fan, and a Relay for the Lights .

This takes up less than 40% of the box!

Plexiglass shelf separates and holds the electronics

Camera positioned on side to optimize viewing and picture or video collection

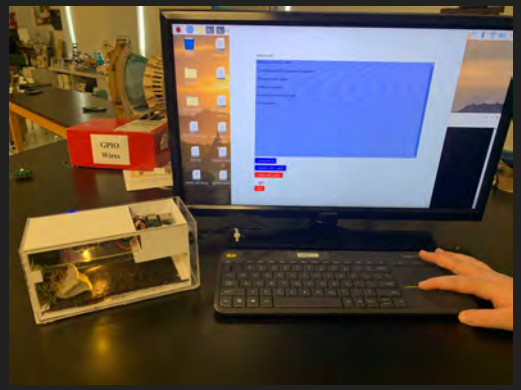


What's Inside?

The main chamber contains: a mesh layer to facilitate breeding, moss to ensure oxygen levels are not depleted and to hold dew for the crickets to hydrate, and parts of an egg carton to allow for natural hiding behavior (on Earth) and as something to hold onto (on the ISS)

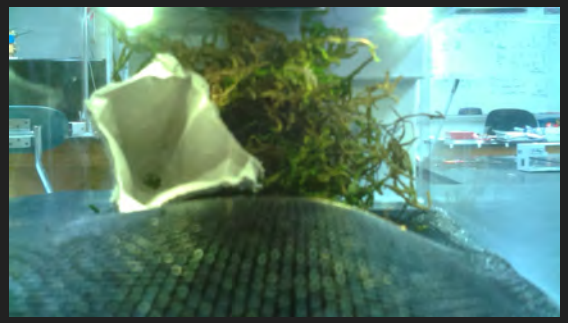
The main chamber also contains the crickets' food; which, consists of crushed peanuts, crushed pecans, and arrowroot. (we are continually tweaking the recipe)This mix is then blended to avoid the crickets only eating their favorite foods, they can be quite picky!

The Graphic User Interface (GUI)



Features of the GUI

- Activates on start-up
- Buttons Activate
  - Camera
  - Lights
  - Video
- Environmental Sensor & Data Collection
  - Temperature
  - Humidity
  - Dew Point



Camera View!


Insect Nanolab
Warren Tech Central
Nate Olsen
Christian O'Canna, Elliot Berger,
Audra Evans, Ben Ramey
Team Name: G.L.E.N.N (General Lab for Entomology and Natural Nutrition
Team Logo
GLENN
Research
Although the lab is for all types of bugs, we specifically studied mealworms for weeks. Here are some things we learned:
• They don't like harsh, bright light
• Can climb up hot glue
• Don't need a lot of food/hydration to survive
Bug Experiment
Materials
• ABS Plastic
• 4x2mm Magnets
• Electronics/Sensors
• Rubber
• Threading Inserts
• Sponge
• Netting
(Full Box)
First Cage Design
Most Recent Cage Design
(Testing Data)
Electronics
Bug Inc
Chatfield Senior High
Cosmo Laubacher, Ben Toll, Sienna Fischer

Insect Nanolab

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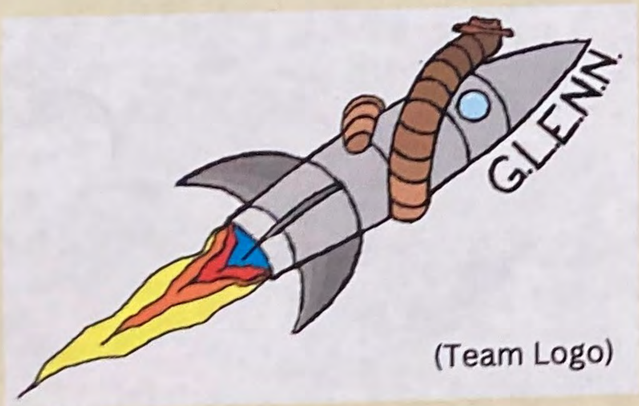
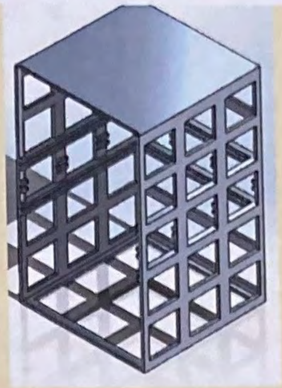


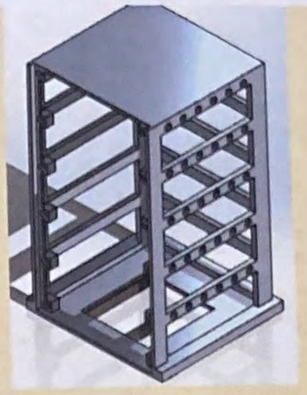
(Team Logo)

Materials

- ABS Plastic
- 4x2mm Magnets
- Electronics/Sensors
- Rubber
- Threading Inserts
- Sponge
- Netting



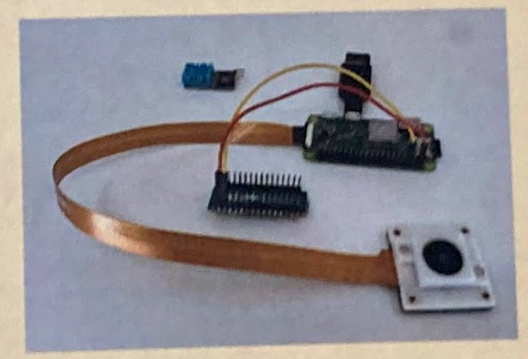
First Cage Design



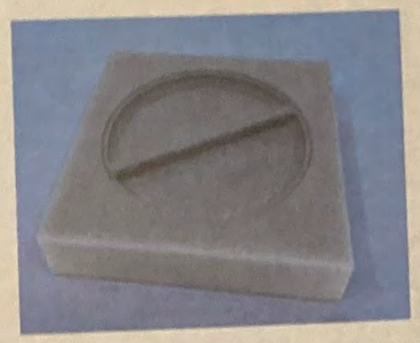
Most Recent Cage Design

Cage Prototype

Box Prototype



Electronics



Cut Out Section of the

Research

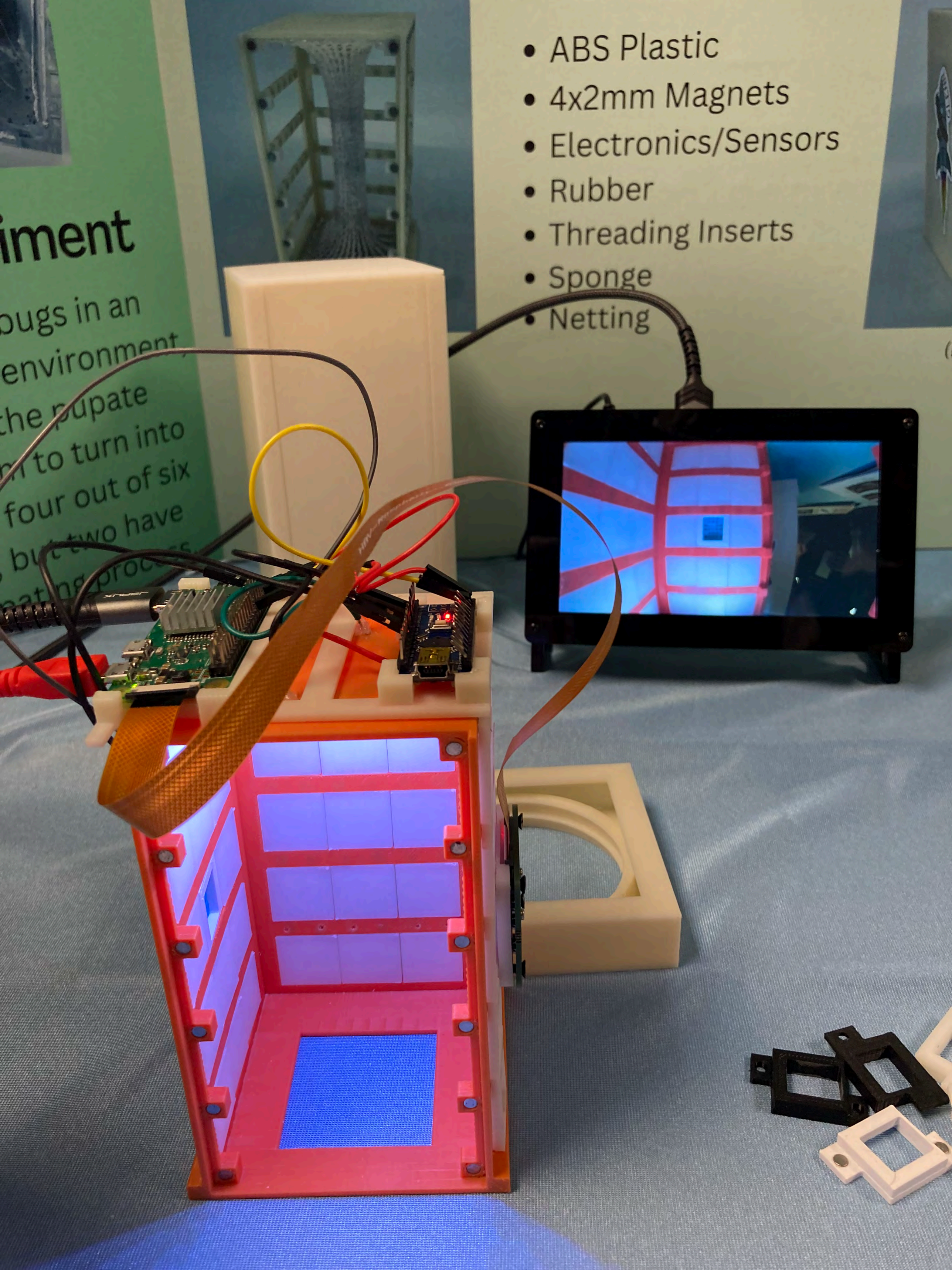
Although the lab is for all types of bugs, we specifically studied mealworms for weeks. Here are some things we learned:

- They don't like harsh, bright light
- Can climb up hot glue
- Don't need a lot of food/hydration to survive

Bug Experiment

By putting the bugs in an isolated and dark environment, we triggered the pupate process for them to turn into beetles. Sadly, four out of six passed away, but two have begun the pupating process.

(Testing Data)


iment
bugs in an
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n to turn into
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but two have
ABS Plastic
4x2mm Magnets
Electronics/Sensors
Rubber
Threading Inserts
Sponge
Netting

Research/Testing

We placed one of our worms into the algae that we grew

Our mixture that we used for food was wheat paste and water, which kept having the issue of molding, but eventually we added a small amount of methyl paraben to reduce the molding.

Meet the Team!

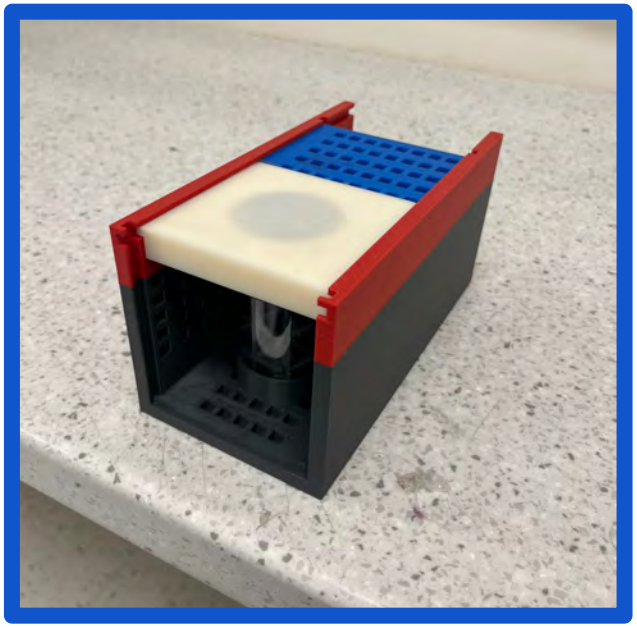
Samantha McCarthy
Molly McDermott
Callie Schweitzer

Website

Contact Us

tc.hunch.nanolab@gmail.com

Insect Nanolab



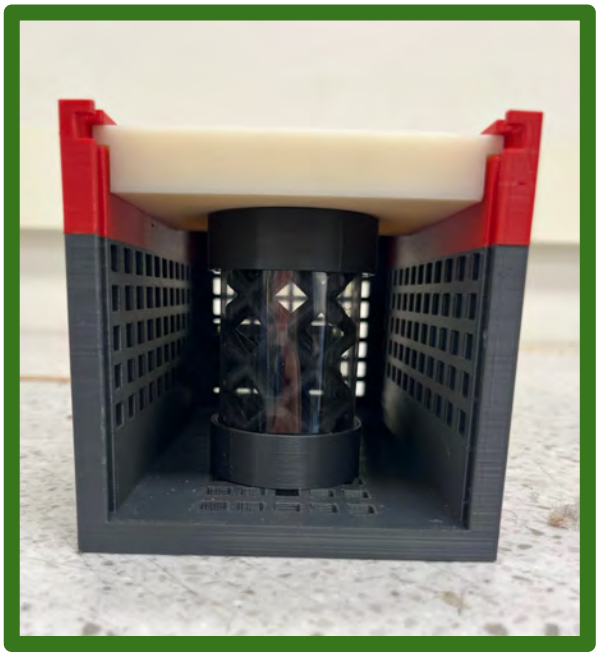
Tri-County RVTHS

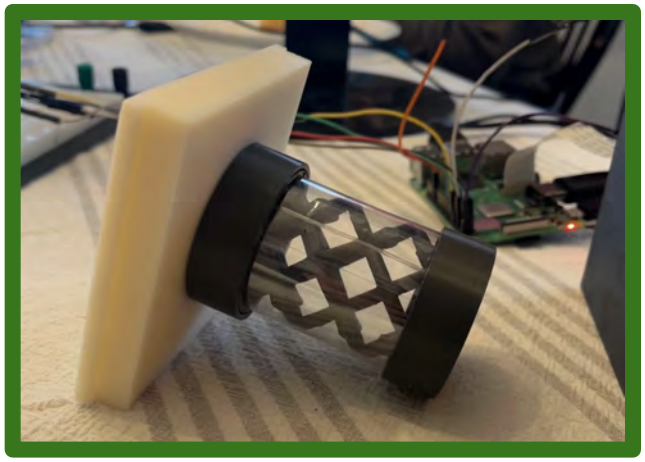
147 Pond St, Franklin MA, 02038

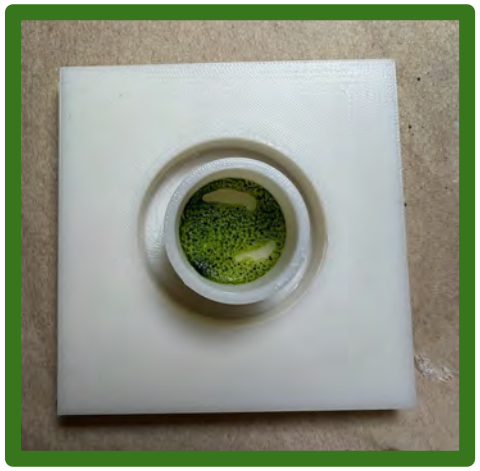
Kristen Magas -

magas@tri-county.us

Customizability

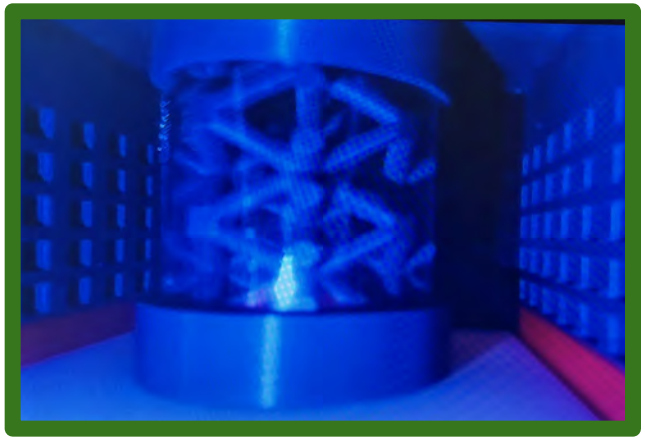


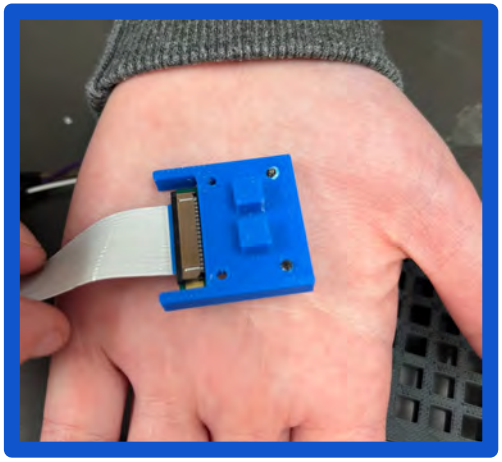




Our Insect Nanolab features a grid for customizable locations of electronics.

The insects reside in a 3D printed lattice structure coated in dried paste. The lattice is fit inside a container that can be open to algae to act as a source of oxygen, moisture, and food.





NASA HUNCH

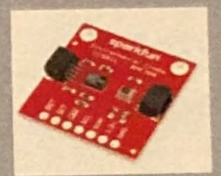
INSECT NANO LAB

Council Rock High School South
Ms. Mangold and Mr. Boyle

JET LI, SEAN KLEIN, EMMA KAPLAN, SHAKIRA ALI, MIA BLAKE, AND ISABELLA THOMAS

MATERIALS

Box:
- Polymaker PLA
- Acrylic Shell
- Mesh
- Adhesive
- Silica Gel



Electronics:
- Arduino
  - Servo Motor
  - Sparkfun WS2812B Breakout RGB LED lights
- Raspberry Pi
  - Raspberry Pi Camera V2
  - Sparkfun Qwiic pHat
  - Sparkfun Environmental Combo Breakout CCS811/BME280 (Qwiic)
- Brushless Fan (Makerfocus)

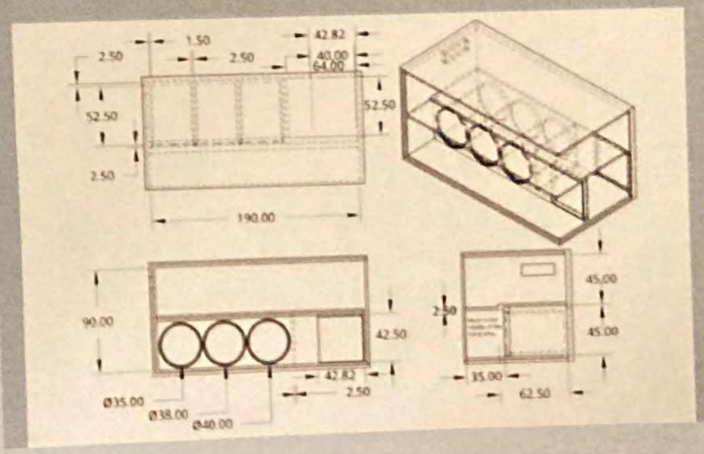
Crickets:
- House Crickets
- Thick Water
- Cotton Balls

OUR DESIGN

Our insect nano lab includes a 10x10x20cm box with multiple cylinders and a mesh protective layer. Springs with a panel attached are used to push the food toward the crickets and 2 40x40x10mm fans are embedded in the border of the box to circulate the air. There is also a shelf dividing the crickets where the circuitry and electronics are placed and silica gel packets are placed around the electronics to keep moisture away.

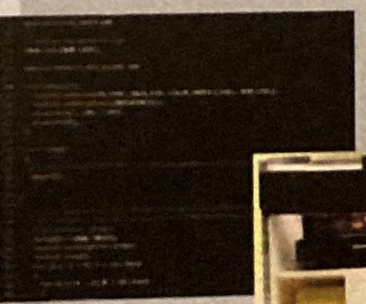
An Arduino nano is used to control a set of window wipers to remove particles from the camera lens and a Raspberry Pie V2 camera is placed at an inclined angle towards the top. In addition, LED light is used to resemble how crickets are normally fed in the sunlight. Due to their nocturnal habits, the lights will become dimmer when they feed.

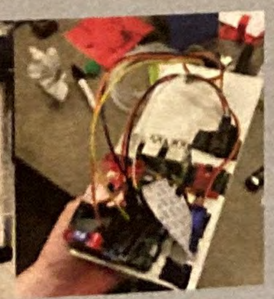
Our Current Design:



OUR CODE

Our code consists of a web server hosted on the Raspberry Pi that displays the camera inside the box and should allow anyone on the same WIFI network to view it. The Pi also gathers environmental data and logs the data into a .txt file which also visually appears on a graph. The code on the Pi is written in Python, and we used Tkinter to make the GUI which displays the data and opens the webserver. The graphs are run using matplotlib.
The Arduino runs the servo motor that clears debris from covering the camera and also handles the lights which include a day-night cycle of 16 hours of bright light and 8 hours of dim light. We also began to code a water system that would pump water into the cotton balls so the crickets can stay hydrated.





RESULTS

DATE: 11/7/22: Box Test
- First Draft of Box 3D printed
- Determined to use House Crickets as insect
- Code for V2 camera and motor is written

DATE: 12/2/22: Electronic Test
- Relative Humidity: 25.544%
- Temperature: 24.86°C
- Pressure: 24024.2 Pa
  - Code for LED is written
  - House Crickets purchased
  - Assembled fan, camera, and servo motor
  - Code for environmental Sensors written for Pressure, Relative Humidity, and Temperature
  - Redesigned box to hold 2 brushless fans to circulate more air

DATE: 1/14-1/20: Cricket Test
- Relative Humidity: 25.469 %
- Temperature: 24.95 °C
- Pressure: 24016.8 Pa
  - First Testing of Crickets in Box
  - 2/4 Crickets died
  - Cotton Balls are used for food source
  - Crickets chewed through adhesive for mesh

DATE: 2/18-2/21: Cricket Test
- Relative Humidity: 25.266 %
- Temperature: 25.08 °C
- Pressure: 23990.8 Pa
  - 2/3 crickets died
  - Make a hydration system (cotton balls ran out of water)
  - Possibility of fan batteries dying (lithium batteries may be a better option)

DATE: 2/22/23: Water Test
- Finished code for wipers for camera
- Started to code for Water System
- 3D printed parts of Water System
- Final Design of box printed
- Trifold and Brochure assembled

Pros/Cons

Pros:
- Crickets: Omnivores + self-regulating. They release waste that has low CO2 levels
- LED lights: Clearer imaging and helpful to regulate eating patterns at night
- Brushless Fan: Doesn't need too much energy, and they can be used with a filter - circulate air
- Electronics: Generate heat - can be regulated

Cons:
- Crickets: Produce large amounts of waste that could carry various diseases. They also produce a lot of offspring (issues with space) and require heavy ventilation
- Brushless Fan: Could potentially injure the insects and may circulate waste
- Adhesive for Mesh: Crickets chewed through the glue
- Cotton Balls: Only hold limited water (led to dehydration)

For the Future

- FUTURE TESTS
  - Symbiotic relationship between cricket waste and photosynthetic algae
  - Test with thick water and regular water
    - Thick water is more viscous- more surface tension
  - Condensation system
    - Keep water in the enclosure

MINNETONKA ENGINEERING PROGRAM

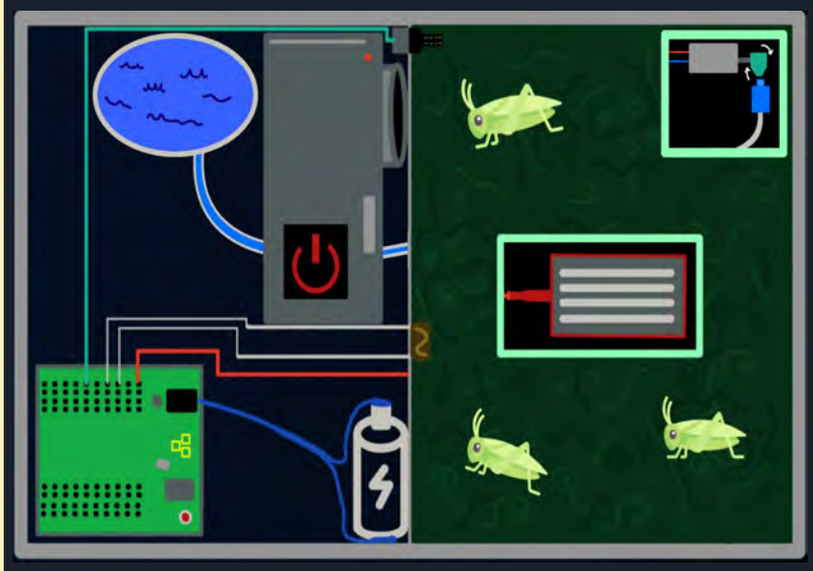
One Page Project Overview

Team info

Minnetonka High School

Mr. Burfeind

Tyler Vos, Liam Cassidy

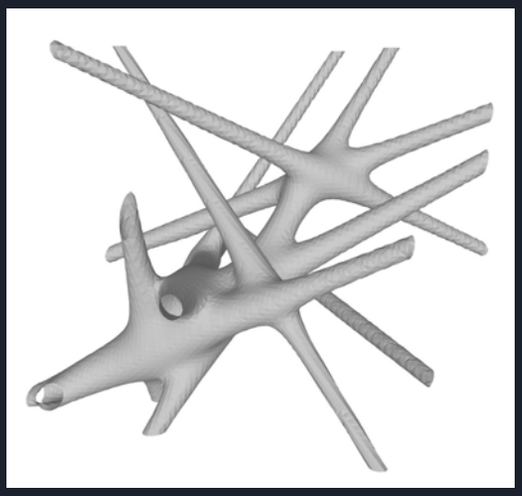


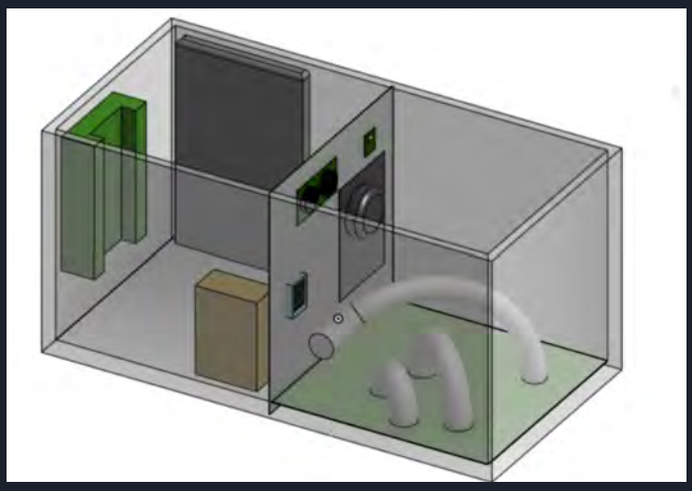
The main features of the nano-lab are the sensors and ability to monitor and grow insects. These features are achieved through a variety of sensors, including: temperature, light, moisture, and oxygen sensors. Those sensors are hooked up to a set of arduinos to facilitate the information. When one of the sensors detects a issue or discrepancy, a light will turn on, indicating what sensor is no longer balanced. There is also a pinhole camera along with a mirror in our design to directly monitor the crickets. Additionally, there is an automated water pump to ensure the crickets stay hydrated.

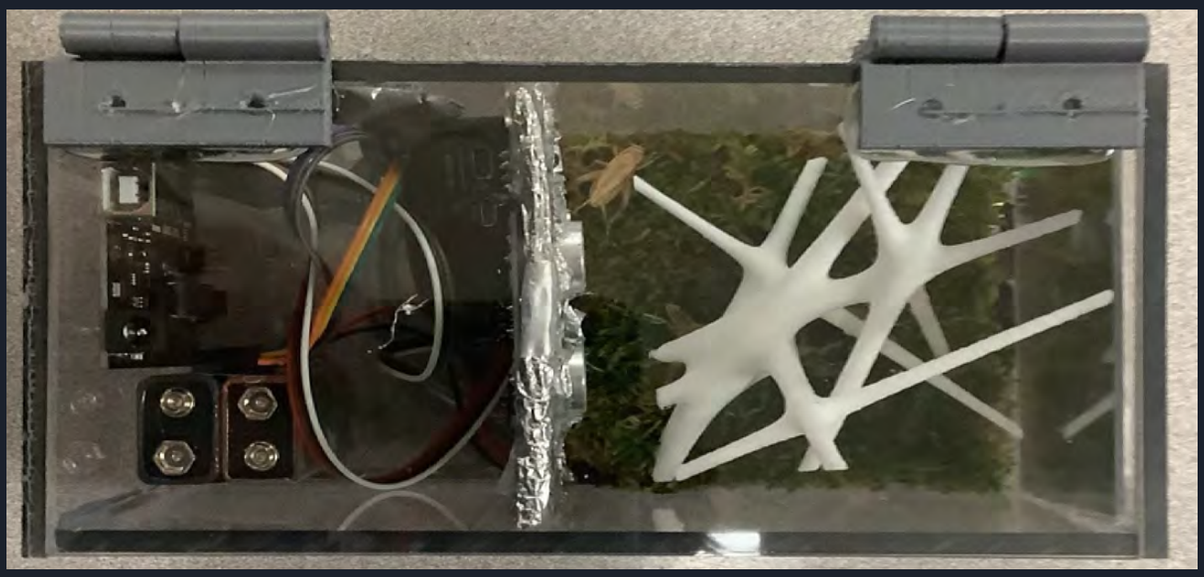
Before the construction of the project, we needed to gain a deeper understanding of how and what the nano-lab needed to provide to keep the crickets living. Testing and secondary research for the project were conducted to discover what those needs were. Experiments on the crickets were done to determine what sensors we needed and what kinds of plants were most beneficial. After the testing was finished, we decided moss was the ideal plant for the lab due to its previous testing in space and relatively low maintenance, as well as it being a food source and waste management for the crickets.

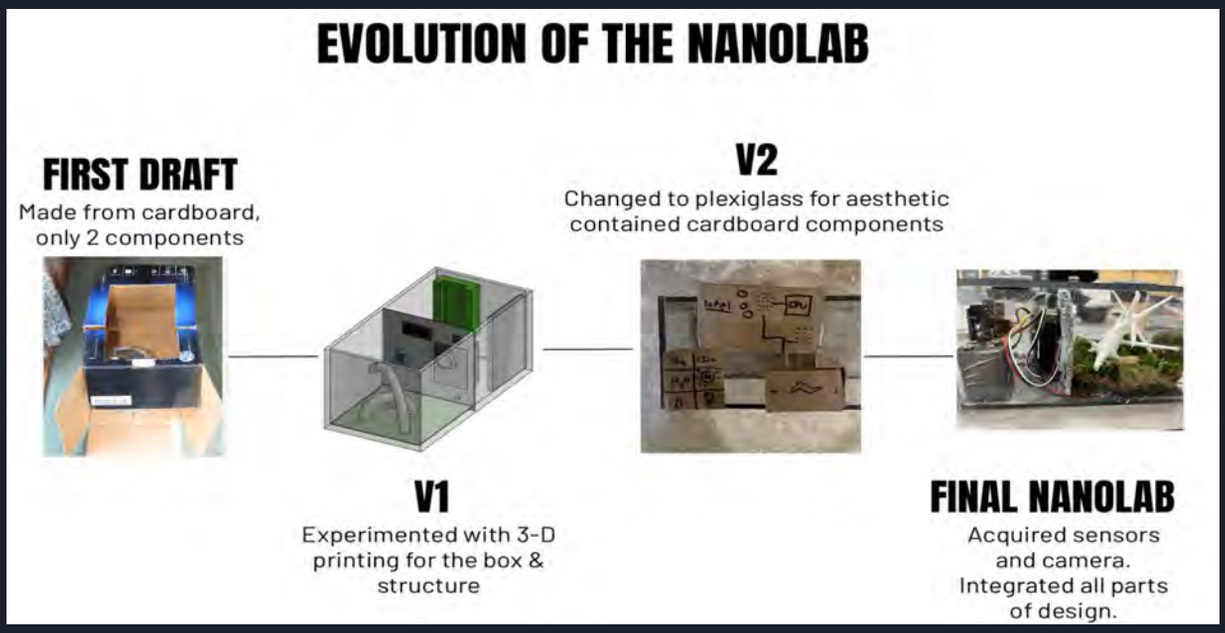
MINNETONKA ENGINEERING PROGRAM

Photos of our Design Process









MINNETONKA ENGINEERING PROGRAM

Photos of Nano-Lab