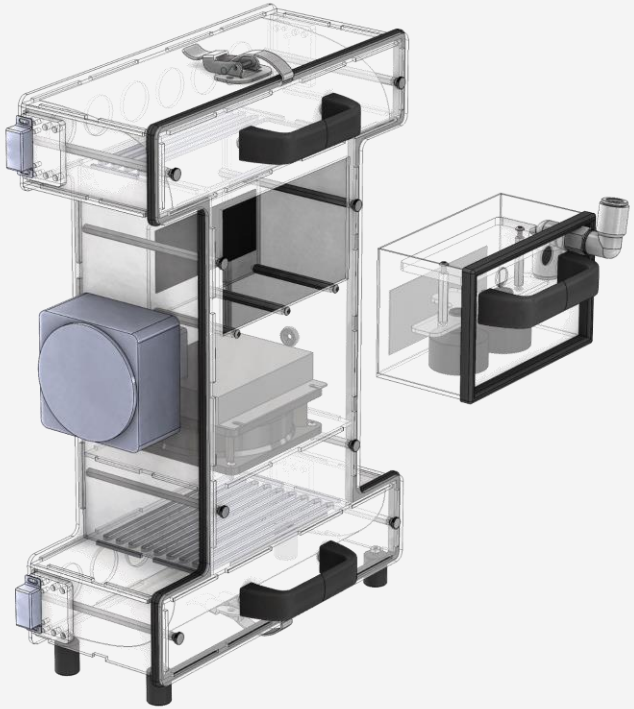

Fermentabot

Small-scale, digitally controlled fermentation
for upcycling of food waste

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Fermentabot Project Overview

Mechanical Specifications and Requirements

1) **Housing and storage**
    1) Insulated food storage box and perforated food pans/cotton cloth

2) **An “Environmental Chamber”**
    1) A device that can be attached/removed from the catering box and contains all the mechanical actuators such as heaters and fans.

3) **Air circulation heating/cooling system**
    1) 12V Peltier Cooler
    2) 12V heating element
    3) 12V equipment-cooling fan

4) **Humidification system**
    - External humidification cartridge
    - Miniature ultrasonic fogging technology

5) **Control System**
    1) Humidity and temperature control

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Design Progress

- Initial designs considered water heater/chillers for controlling ambient temperature
- External enclosures were considered for any onboard electronics/power supplies
- Off-the-shelf components were to be used whenever possible
- OpenAg already had inventory of heating units, fans, tubing, chillers, pumps etc. for rapid prototyping

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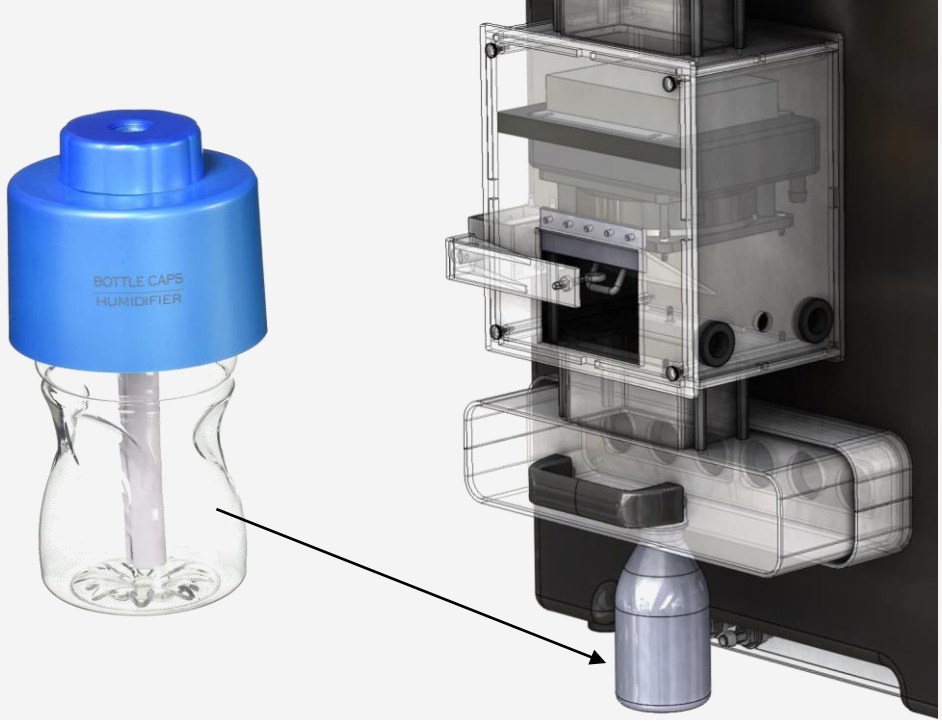

Humidification Testing and Prototyping – Early Stage

- The goal was to use various off-the-shelf humidification solutions
- Pressurized water through spray nozzles created too much direct condensation on the koji cloth
- Bottlecap humidifiers did not provide enough moisture to the system
- Iterative testing led to the selection of an ultrasonic fogger

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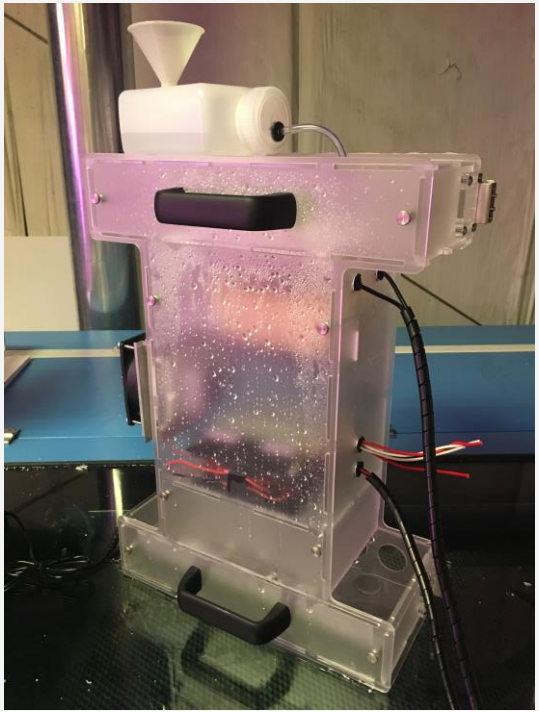

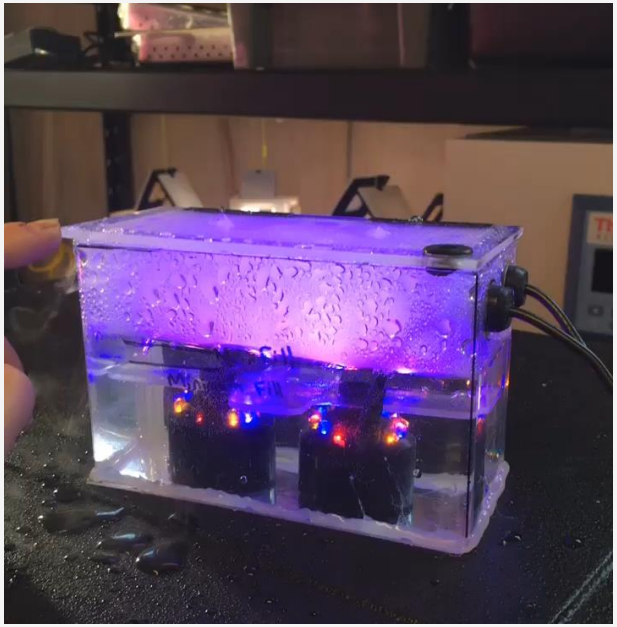

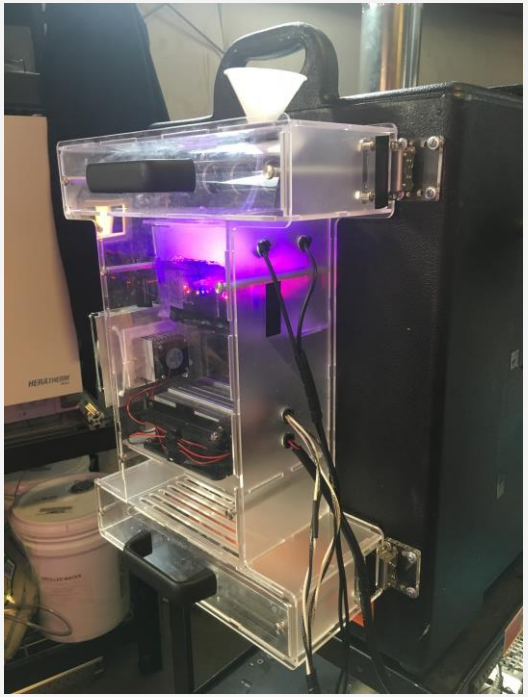

Humidification Testing and Prototyping

- Final selection: **FITNATE Ultrasonic Mist Maker**
- Environmental Chamber design necessitated a combination of off-the-shelf and custom solutions
- Various designs were considered for integrating the humidifier and controlling humidity levels
- Testing showed that two units were necessary to reach required humidity levels

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Humidification Testing and Prototyping

- Humidifier was integrated into Environmental Chamber so that it could be removed for maintenance and refilled automatically
- Water use approximates 1 mL/min, or 2.2 L over the course of a 36hr fermentation

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Design Progress

- khjkhgj
- Asdads
- asdad

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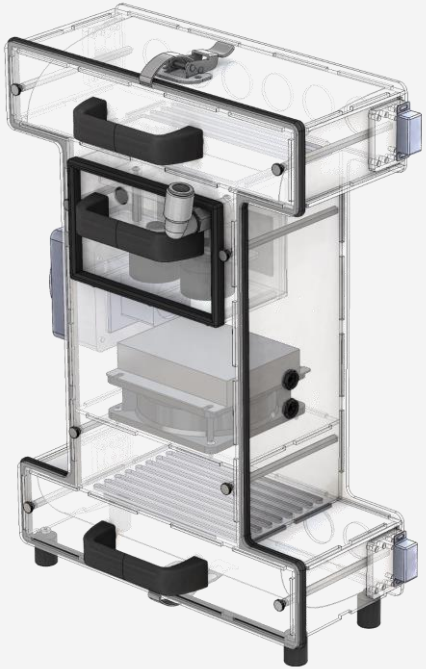

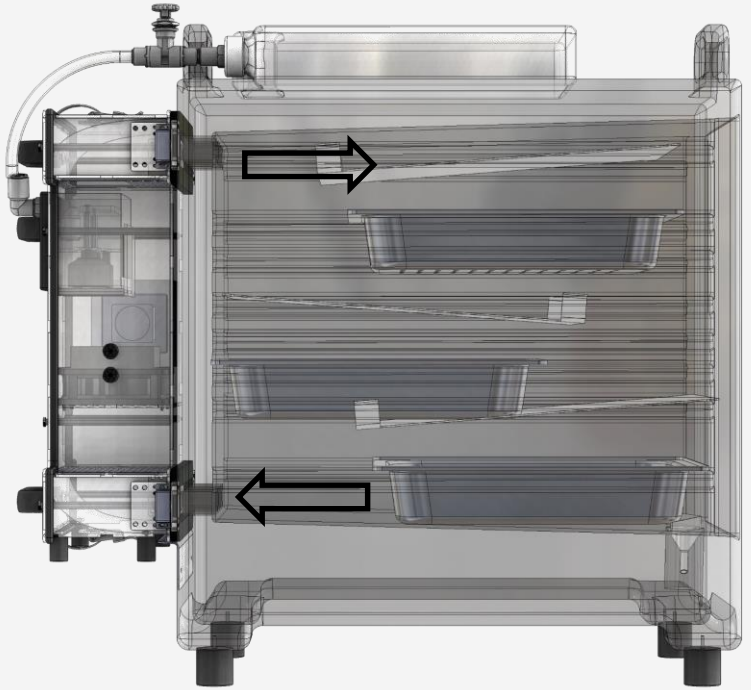

Design Progress

- sdfgsdg
- Asdads
- asdad

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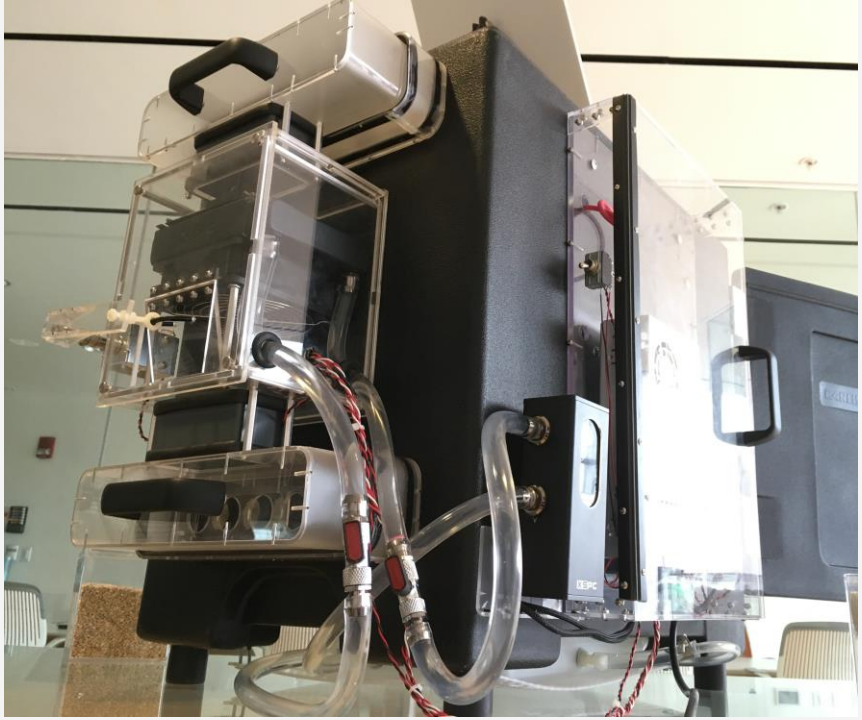

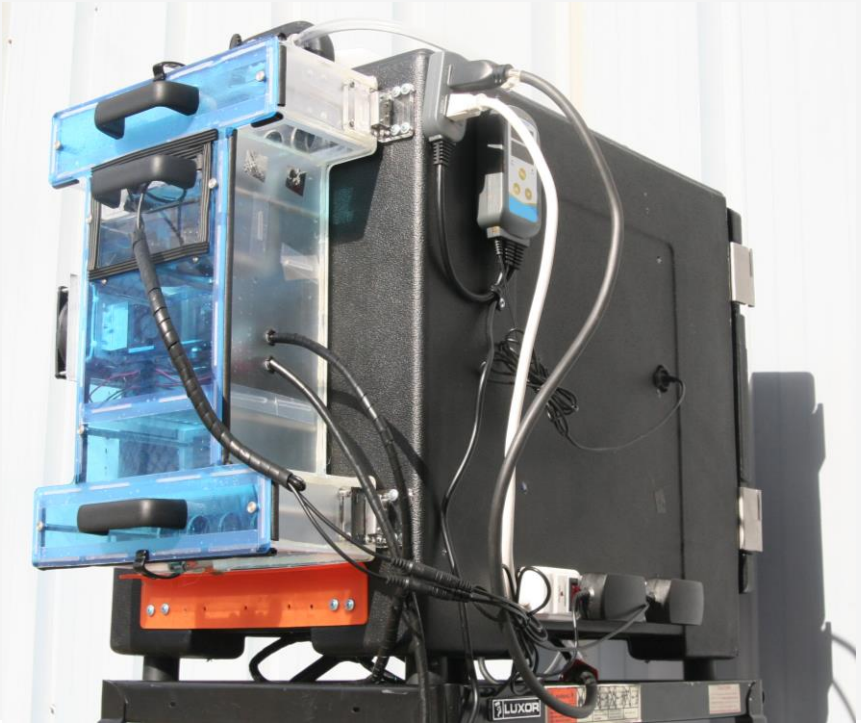

Design Progress

- dfgsdfgChamber sdfgsdg
- Asdads
- asdad

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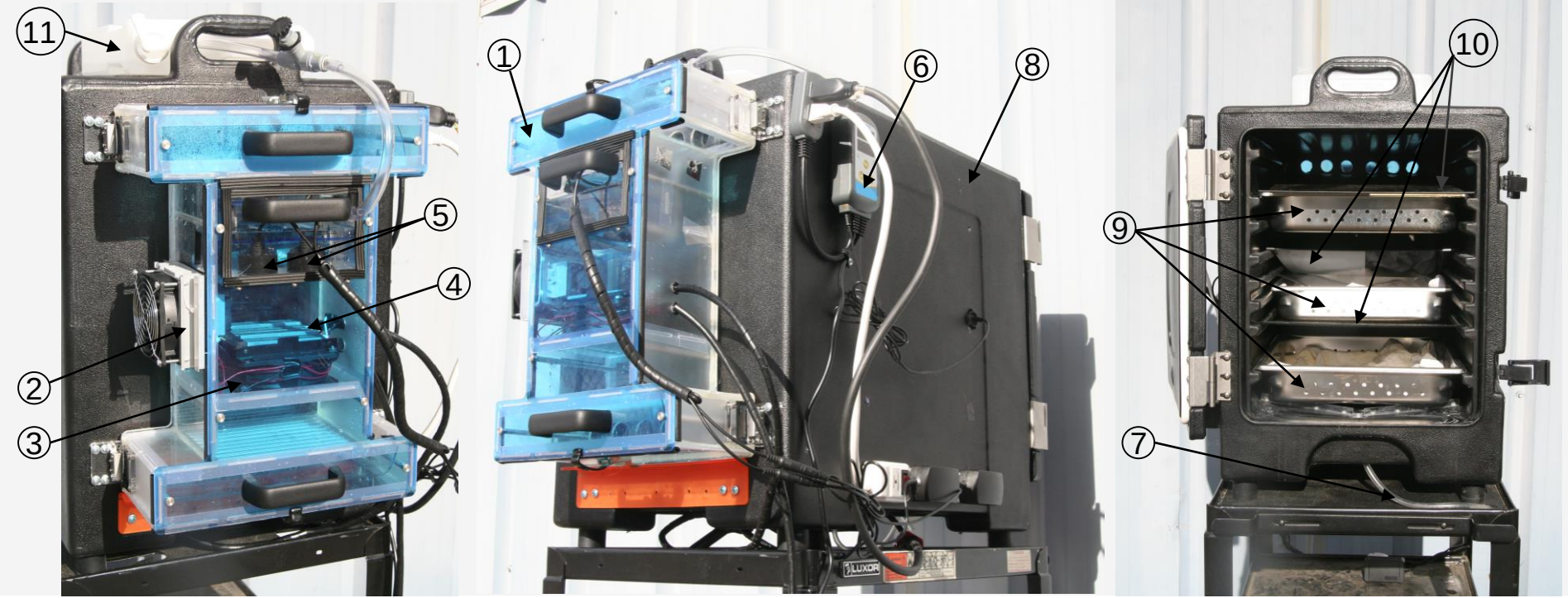

Design Overview

1. Environmental Chamber
2. Piezo Cooler
3. Fan
4. Heater
5. Humidifiers
6. Temp/Humidity Control System (with live readout)
7. Condensation Exit
8. Insulated Food Pan Carrier
9. Food Pans (with cloth covers)
10. Condensation Protectors
11. Humidifier Unit Refill Reservoir

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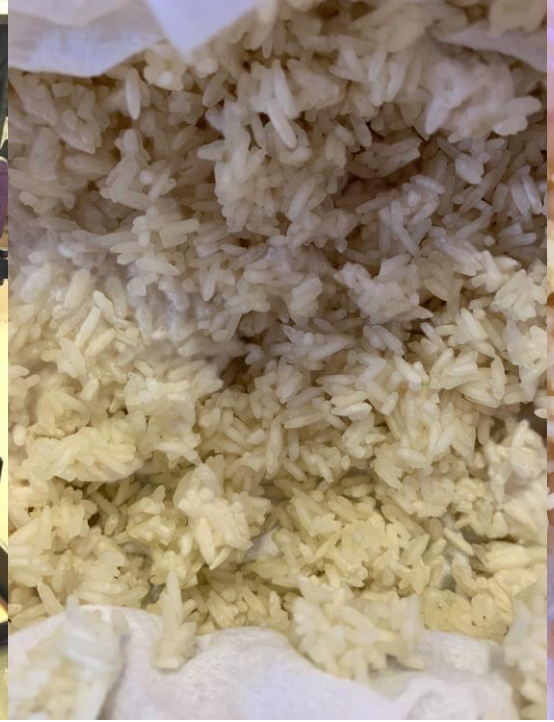


Testing Results

- Koji grown successfully at 32°C and 80% RH
- Previous control system was unreliable, so only one batch was grown until a better control system could be integrated

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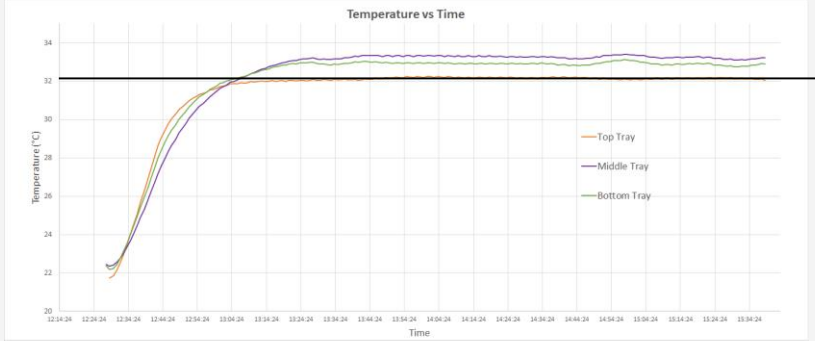
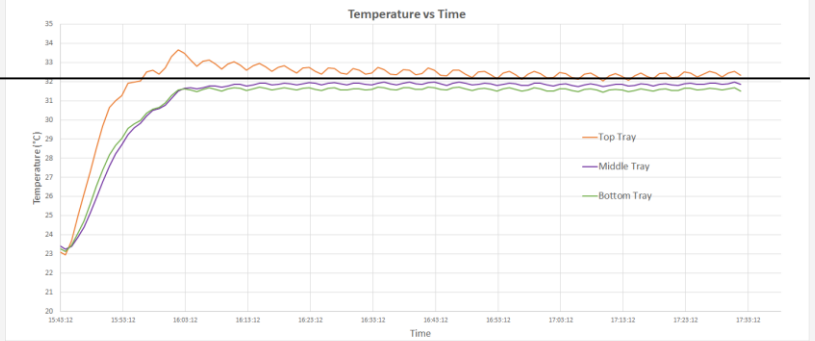
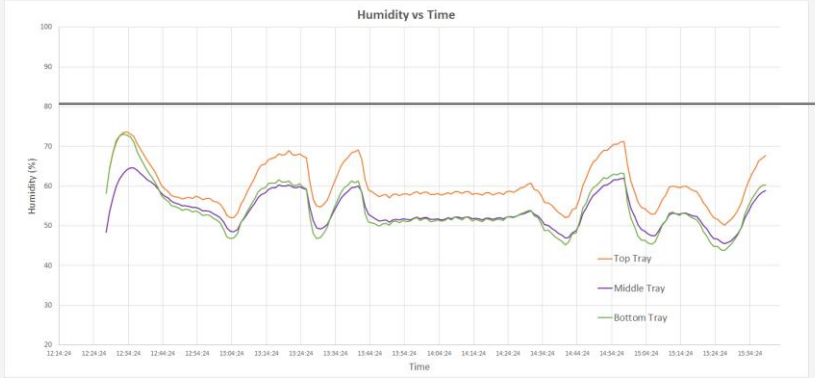
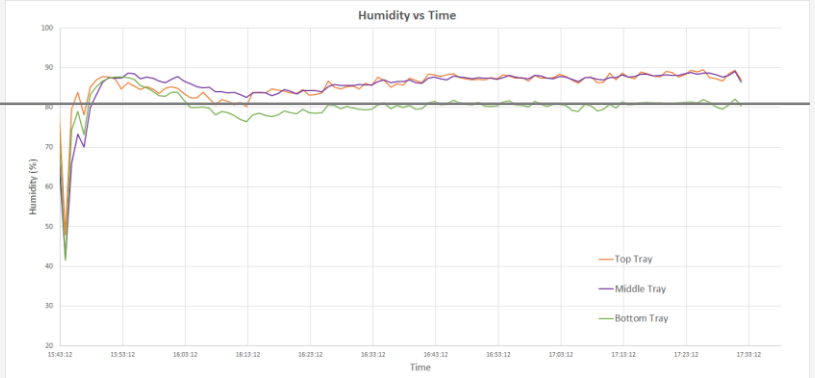


32°C





80% RH



Testing Results

- Two hour burn-in tests helped in characterizing the sensitivity of the environmental controls
- Location of temperature sensor affected the temp/humidity of each tray
- Data collected with Omega OM-92 sensors
- Asdads
- asdad

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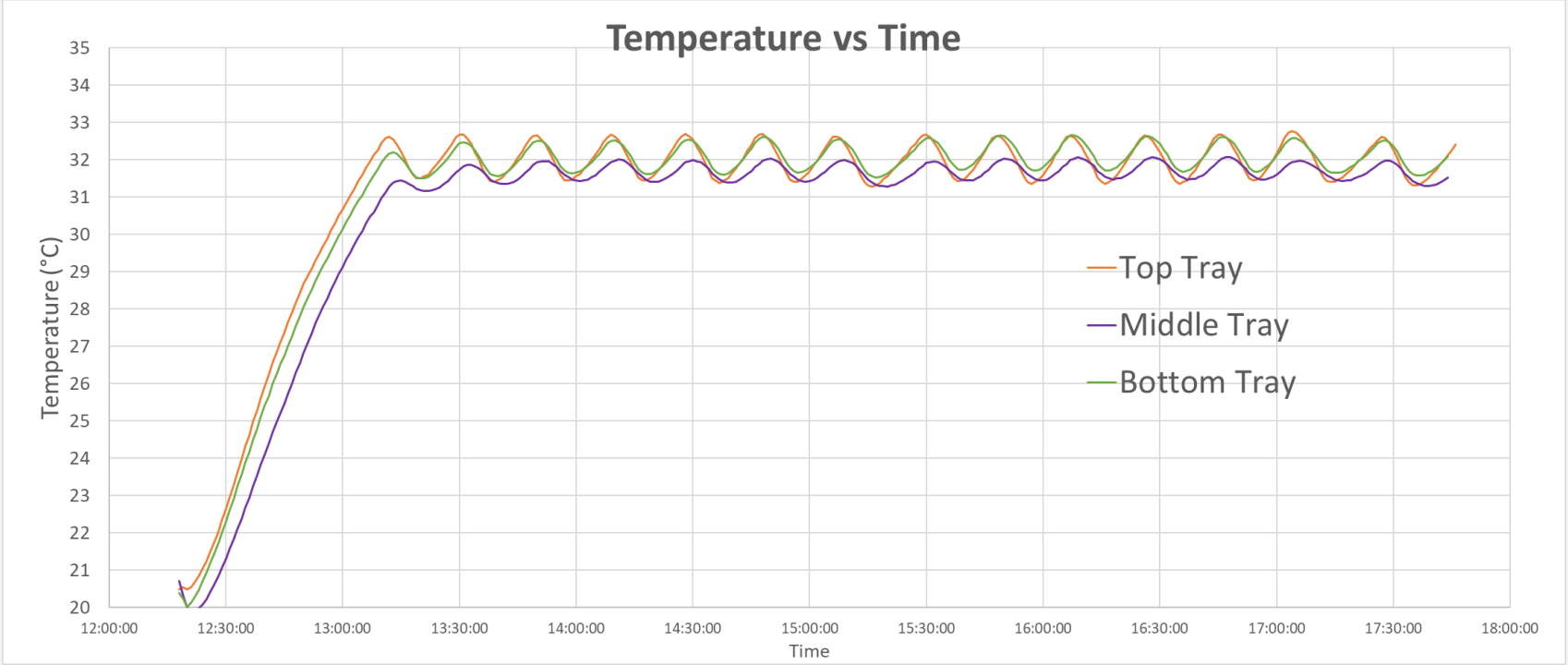

Testing Results

- Temperature from 25°C (ambient) to 32°C in approximately 20 minutes
- ~0.5°C difference between each tray, based on air flow clearance inside
- Temperature set to 32°C with bounds at +/-1°C
- Adasd
- Asdads
- asdad

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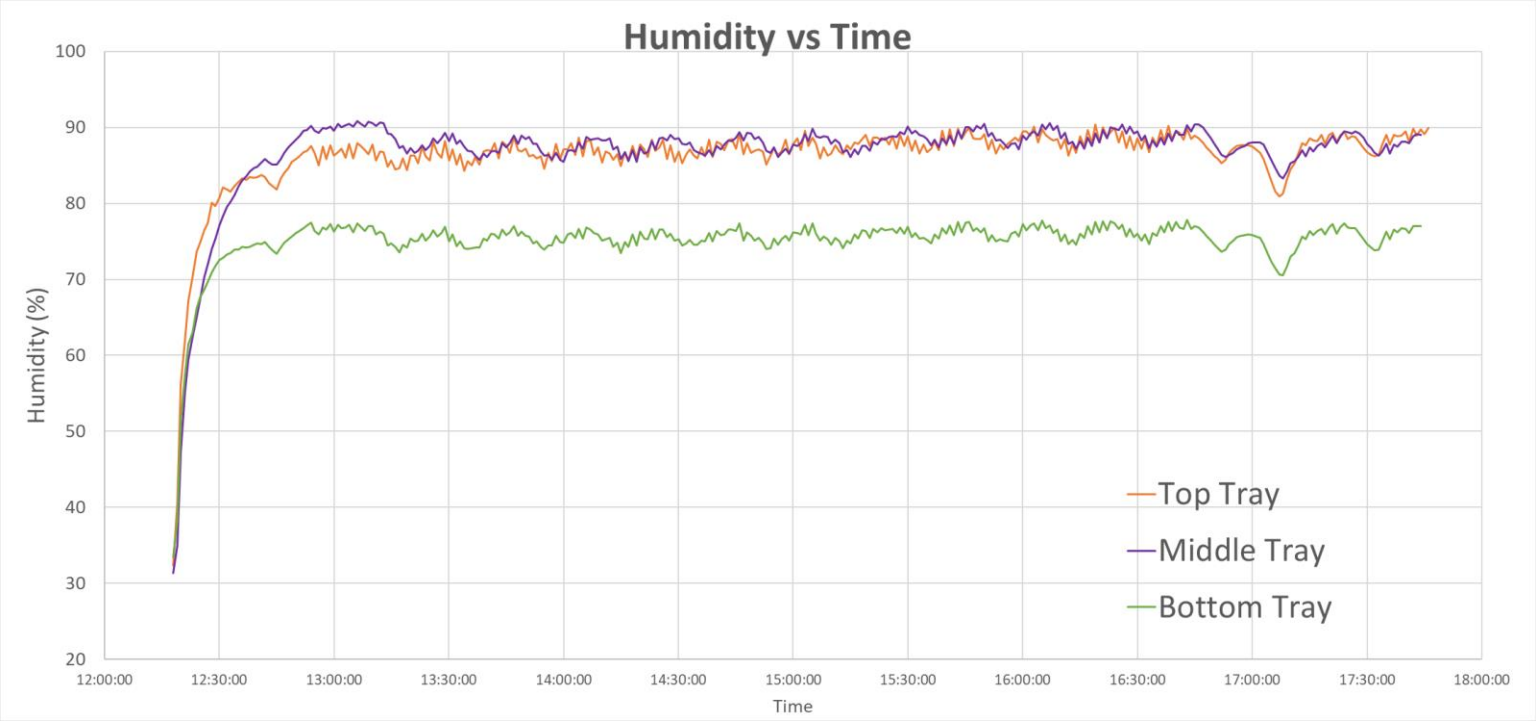

Testing Results

- Humidity from 50-60% RH (ambient) to 80-90%RH in approximately 10 minutes
- ~10%RH variance between the top and bottom tray, based on air flow clearance inside
- Humidity set to 80.5%RH +/- 1%
- Bottom tray feels least amount of humidity, most likely due to bottom-most Condensation Shield (more testing necessary for optimization)

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Budget and Next Steps

1) Approximately 25% of the Fermentabot Project budget has been spent developing a fully functioning prototype
    1) This includes 3D design, documentation, fabrication, assembly, and mechanical testing o two prototype Fermentabot units (1.1 and 2.0)

2) Next development steps include
    1) Improving mechanical seals on Environmental Chamber
    2) Improving humidification unit water refill system
    3) Software and hardware development
        1) Creating, fabricating, and testing a circuit board
        2) Creating an online user interface that can control the Fermentabot and collect data via wi-fi
        3) Integrating the software/hardware development into the existing Fermentabot prototype

TOTAL MATERIAL PURCHASES:	**$ 2,160.93**
Hours Worked (Eugene) (approx. 4.75 full time weeks)	187
TOTAL LABOR:	**$ 5,610.00**
TOTAL BUDGET SPENT ON FERMENTABOT:	**$ 7,770.93**

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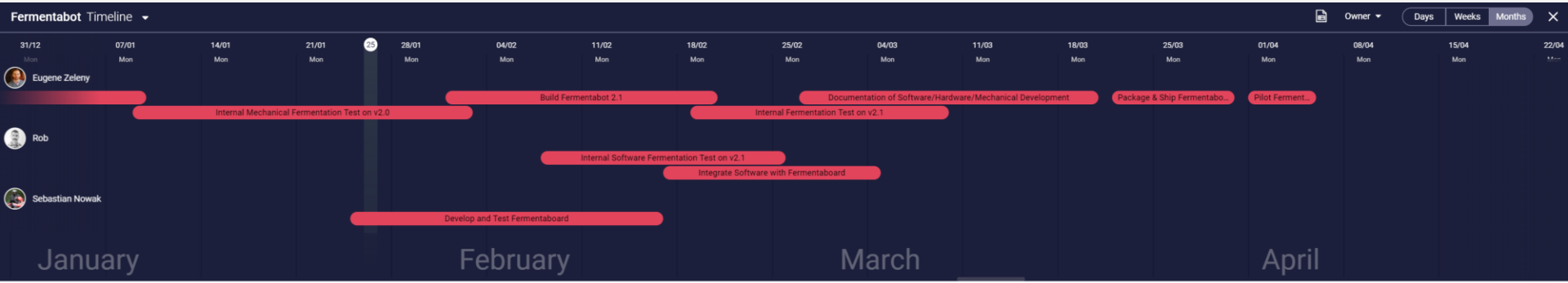

Timeline	Owner	Status	Due Date	Timeline	Link
Develop and Test Fermentaboard		Working on it	Feb 16	Jan 24 - Feb 15	
Build Fermentabot v2.0		Done	~~Jan 9~~	Dec 4 - Jan 8	
Internal Mechanical Fermentation Test on v2.0		Working on it	Jan 31	Jan 8 - Feb 1	
Documentation of Software/Hardware/Mechanical Development		Waiting to Start	Mar 5	Feb 26 - Mar 19	
Build Fermentabot 2.1		Waiting to Start	Feb 15	Jan 31 - Feb 19	
Internal Fermentation Test on v2.1		Waiting to Start	Feb 28	Feb 18 - Mar 8	
Internal Software Fermentation Test on v2.1		Waiting to Start	Feb 19	Feb 7 - 24	
Package & Ship Fermentabot to Diego		Waiting to Start	Mar 15	Mar 21 - 29	
Pilot Fermentabot w/Diego		Waiting to Start	Mar 26	Mar 31 - Apr 4	
Integrate Software with Fermentaboard		Waiting to Start	Mar 2	Feb 16 - Mar 3	

Timeline Breakdown

- Koji grown successfully at 32°C and 80% RH
- Previous control system was unreliable, so only one batch was grown until a better control system could be integrated

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Options for Next Development Steps

1) No software integration:
    1) As it stands, this Fermentabot prototype is a plug-and-play device – if you plug it into the wall, it will run a single recipe (32°C, 80%RH), until you unplug it, without any software
    2) Copies of this prototype can be fabricated and sent to Diego ahead of the previously described timeline

2) Software integration:
    1) Creating the PCB, online user interface, and software for running the Fermentabot will give users more control over recipe creation and data collection.
    2) Timeline will reflect previous slide

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Thank You.

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