College of Engineering
Department of Mechanical & Industrial Engineering

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School of Electrical Engineering & Computer Science

To Predict ▶ To Design ▶ To Perform

ME, ECE Capstone Design Programs

Team#44:Passive Decentralized Black Soldier Fly Rearing System

Aprizky Heldinto (ME), David Hunt (ME), Ade Istianto (ME), Brett McDonald (ME), Deby Syahera (ME)

FLUKER'S ESTABLISHED 1953

Background


https://www.standardmedia.co.ke/images


http://www.carolinapetsupply.com/catalog/images/soldier.jpg

- The larvae of Black Soldiers Flies (BSF) are a nutritious food option for animals and fish
- BSF larvae have potential to decompose food waste into fertilizer by its residue (frass).
- BSF larvae have potential to be a new market for animal feed

Objective Statement

The main objective is to **optimize** the production of the BSF larvae in the fly rearing system and **maximize** the production of larvae (prepupae stage) each harvest time. The system needs to be **semi-automated** to reduce man power by utilizing control systems such as temperature and humidity control and a separating system for larvae and fertilizer. Furthermore, it needs to be **movable** to fit into a shipping container, and be a closed and passive system.

Engineering Specification

Specification	Expected	Results
Larvae Density	8 larvae / cm^2	8 larvae / cm^2
Dimension	10 ft x 8 ft x 8.5 ft	2.75 ft x 2.73 ft x 8.25 ft
Temperature	60-90°F	78.5-85°F
Humidity	60-80 %	82-100 %
Rearing Time	10-12 days	12 days
Total Weight Production	• 11.2 kg larvae • 54 kg of frass	• 8.96 kg larvae • N/A
% Larvae Survival	60-70%	96.67%
Mass of Larvae	0.25 g	0.26 g
Average Operator Working Hours	1-2 hours/day	1.5 hours/day
Water Usage	0.1-0.3 liters/second	.115 liters/second
Power Usage	3000 - 5000 W	365 Watts
Strength of Material	• σ_f = 92 KPa • E = 15.96 MPa • K_{IC} = 0.19 MPa.$m^{1/2}$	• σ_f = 97.34±20.41 MPa • E = 3.09±0.038 GPa • K_{IC} = 0.26±0.022MPa.$m^{1/2}$

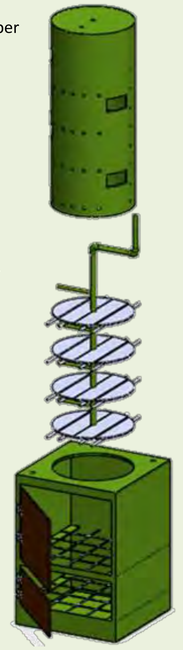
Functional Requirement

- ✓ To rear the larvae
- ✓ To separate larvae from the frass
- ✓ Produce fertilizer as bi-product
- ✓ To collect the final product: Larvae and Frass

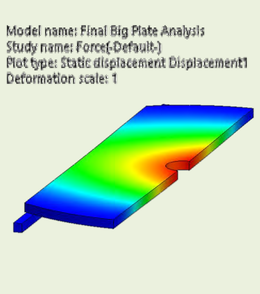
Design Overview

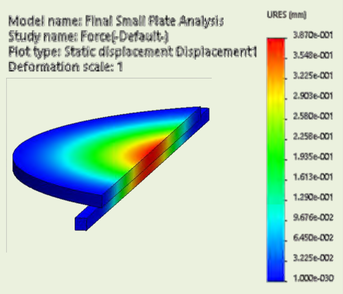
Front View

Side View


Solidwork Exploded View

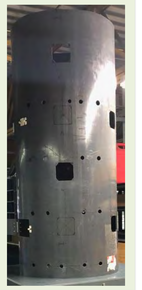
Engineering Analysis





Manufacturing Process

- **Cutting:** PVC flat bar for plates, drawers, outer shell and Aluminum for supports, hinge.
- **Drilling:** Outer shell for support and hinger, bolts, screws and rotating blade placement
- **Joining:** hinge, outer shells, and plates
- **Sealing:** to seal any gap between plates



Safety

- Gloves and breathing mask is used when working inside the system
- Wear PPE during manufacturing and testing
- Aware of grinder. Grinder is specifically used for food waste only. Be careful with fingers and hair
- All materials chosen are corrosion resistant
- Electricity equipment and temperature humidity meter is placed and sealed accordingly to avoid electric shock

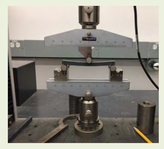
Testing and Validation Process

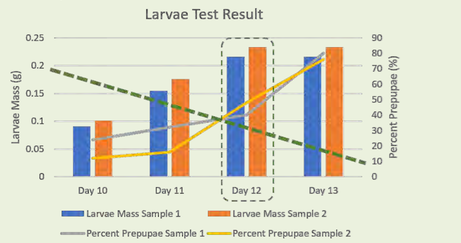
Rearing Test

- Testing Location: LSU Ag Green House Facility
- Objective: Determine optimum rearing time in designated larvae density
- Method: Create replicates of rearing based on condition driven in specification

Material Test

- Testing Location: LSU ME Testing Facility
- Objective: Determine fracture toughness and bending stress to validate strength of material
- Method: Three-point Flexural Test for ASTM D790 and ASTM E5045





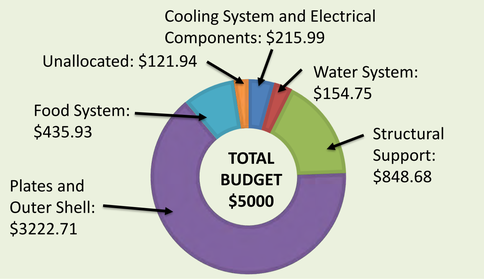
Rearing Validation (Fluker's Farm)

- Testing Location: Fluker's Farm
- Objective: Validate expected specification results
- Method:
  - ✓ Grind food waste and put food waste into system with five-day-old larvae
  - ✓ Rear for 12 days
  - ✓ Harvest larvae and collect data for validation

Conclusion

- The system reared larvae effectively and efficiently to the desired size and exceded expectations on weight.
- The bio-waste to fertilizer transformation was not effective possibly due to high humidity in the system.
- The system could not effectivly separate the larvae and frass esulting in the majority of the frass and some larvae loss.

Budget



- Aug 31 - Sep 30: • Preliminary • Concept Generation • Preliminary Design
- Oct 1 - Nov 11: • 3D Design Drawing • Stress Analysis • Preliminary Rearing Test
- Nov 13 - Nov 17: • Preliminary Rearing Test Result • Finalized 3D Design
- Dec 5 - Jan 1: • Procurement • Manufacturing Preparation
- Jan 1 - Feb 15: • Preliminary Manufacturing • Material Testing
- Feb 15 – Apr 4: • Manufacturing Process • Rearing Test
- Apr 4- May 1: Rearing Validation

Sponsors: David Fluker, Devon Brits

Advisor: Dr. Tryfon Charalampopoulos