Department of Biomedical Engineering
UNIVERSITY OF WISCONSIN–MADISON

Infant Wildlife Incubator

10/06/2023

Advisor: Dr. Wally Block

Client: Dr. Mark Stelford

The Team

Team Leader: Tanishka Sheth

Communicator: Seyoung Selina Park

BPAG: Erwin Cruz

BSAC: Sophia Finn

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Figure 1: Team photo

Client Information

- Dr. Mark Stelford, PhD
- Dr. Stelford is the VP and Treasurer of Oaken Acres and splits his time between the center and another job in Iowa.
- Oaken Acres Wildlife Center has provided wildlife care for over 30 years.
- They have taken in more than 11,000 wild animals since opening.

Figure 2: Image of client [1]

Figure 3: Oaken Acres Wildlife Center Logo [1]

Problem Statement & Client Information

- The project aims to create a low-cost, durable, easy-to-clean incubator that car be used to provide the required environment for orphaned animals who are often neonates/nestlings.
- The design of the incubator should be able to be presented to key individuals at a national wildlife rehabilitators conference in February 2024.

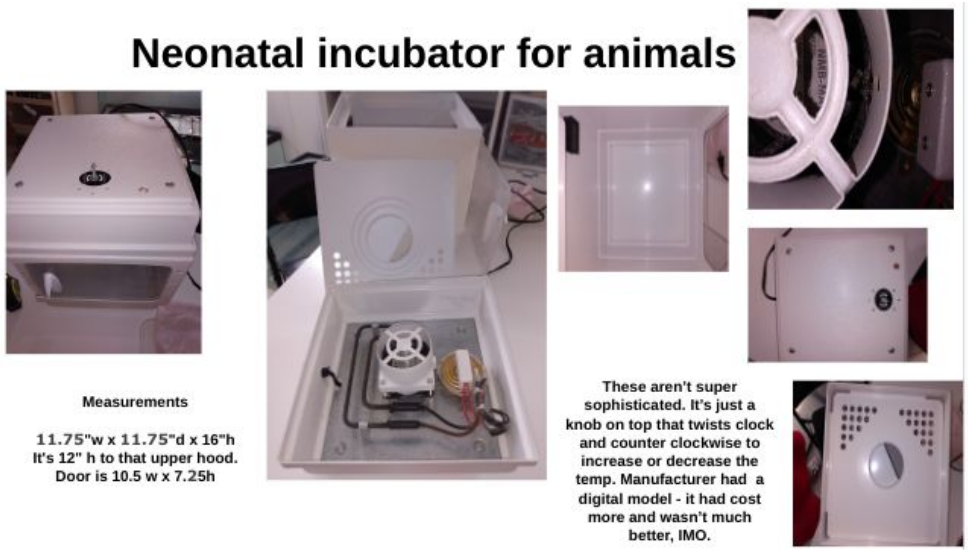


Figure 4: Designs that Oaken Acres has used in the past

Background

- The goal of wildlife rehabilitation is to treat sick, injured, orphaned, and otherwise distressed wildlife, and release them back into their natural habitat [2].
- Wildlife rehabilitation incorporates the care of orphaned mammals and birds
    - Many are neonates or nestlings who cannot regulate their own body temperature.
        - They require supplemental heat to survive
- Private parties with a passion for saving lives often get involved in rehabilitation efforts, but lack the funds to purchase an incubator to provide the required environment.

Figure 5: Injured squirrel at Oaken Acres [1]

Figure 6: Infant birds at Oaken Acres [1]

Competing Designs

- Brinsea Incubation Specialists
  - TLC-50 Zoologica II ($1199.99) [3]
    - Internal Dimensions: 25” wide x 18” deep x 14” high
    - Accurate digital temperature control adjustable through menu
    - Alarms for high/low temp
    - Automatic humidity control in % Relative Humidity with integral humidity pump
    - Air filtration and exchange
    - Variable fan speeds
  - TLC-30 Eco ($309.99)[4]
    - Internal Dimensions: 9.5” wide x 9.5” deep x 6.5” high.
    - Similar components but no humidity control

Figure 7: Brinsea’s TLC-50 Zoologica II

Figure 8: Brinsea’s TLC-30 Eco

Summary of PDS

Client Requirements:

- Dimensions should be 18” x 18” x 18” and break into a box that is 20” x 20” x 8” or smaller for shipping
- Must be under $100/unit to manufacture
- Should involve modular parts allowing for easy replacement
- Must maintain a temperature of 95 degrees F with a buffer of +/- 2 degrees

Design Requirements:

- Ability to increase humidity up to 60%
- No sharp edges on the interior surface
- Life in service is defined as 10 years
- Easily withstand regular operational use and cleaning regimen:
  - Transport/regular removal of the incubator and its modular parts
  - Sustained weight load from animals on the modular parts
  - Scrubbing and cleaning using high temperatures and/or chemicals on the incubator and its parts
  - Exposure to humid conditions

Humidity Control

Designs

1. **All-In-One Pre-Built Humidifier**

Figure 9: Humi-Care Electronic Humidifier

2. Team-Built Water Automizer and Humidity Sensor Circuit

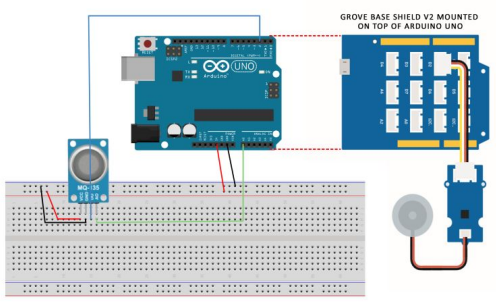


Figure 10: Fritzing Diagram of Water Automizer and Humidity Sensor Circuit

3. Ultrasonic nebulizer and Integrated circuit (IC) type humidity sensor

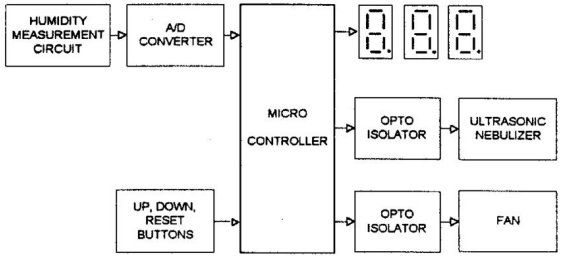


Figure 11: Hardware diagram for ultrasonic nebulizer and integrated circuit (IC) type humidity sensor

Design Matrix Criteria

Criteria	Weight	Description
Accuracy	25	The degree of error of the humidity sensor and the effectiveness of humidity control
Ease of instrumentation	20	The degree of simplicity and efficiency of which the humidifier control, sensors, and humidifier itself can be implemented into the incubator system within the time constraints of the semester
Practicality within an Incubator	20	How safe and robust the system is to regular cleaning; its ability for water level maintenance; and the realisticness that this humidifier system could be incorporated into an infant wildlife incubator.
Usability	15	Ease of changing the humidity, access controls, and ease of refilling the water basin.
Safety	10	Ability to safeguard against harm to the user and the infant wildlife it will be sustaining
Cost	10	Affordability of the system

Design Matrix

Criteria	Design 1: All-In-One Pre-built Humidifier	Design 2: Team-Built Water Automizer and Humidity Sensor Circuit	Design 3: Ultrasonic nebulizer and Integrated circuit (IC) type humidity sensor
Accuracy (25)	3/5 (15)	3/5 (15)	4/5 (20)
Ease of Instrumentation (20)	5/5 (20)	2/5 (8)	3/5 (12)
Practicality within an Incubator (20)	3/5 (12)	2/5 (8)	2/5 (8)
Usability (15)	3/5 (9)	1/5 (3)	5/5 (15)
Safety (10)	2/5 (4)	3/5 (6)	3/5 (6)
Cost (10)	1/5 (2)	4/5 (8)	3/5 (6)
Total (100)	62	48	67

Table 1: Humidity Preliminary Design Matrix

Temperature Control

Designs

Feedback Heater with Bed Detection

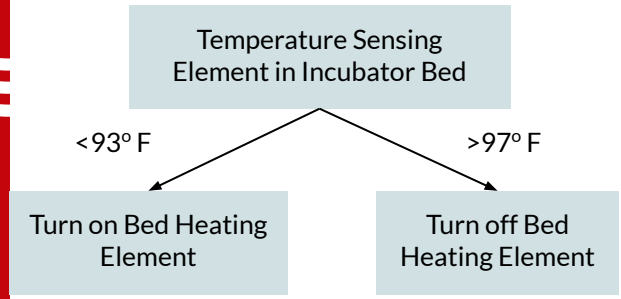


Figure 12: Diagram of Feedback Heater Bed Detection

Feedback Heater with Ambient Air Detection

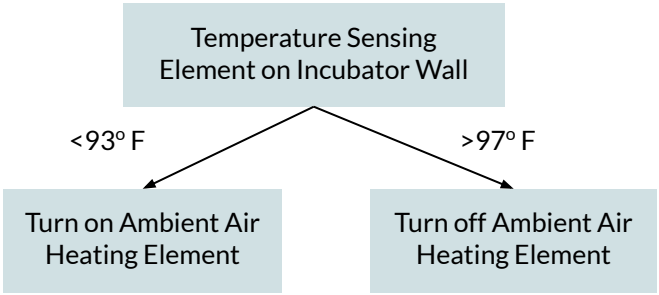


Figure 13: Diagram of Feedback Heater Bed Detection

Modified Arduino Thermistor

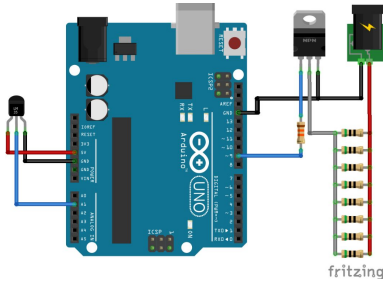


Figure 14: Fritzing Diagram of Arduino-Based Heating Control

Design Matrix Criteria

Criteria	Weight	Description
Safety	25	It is essential to ensure that the heating and electronic elements are not in reach of the animals. The incubator must provide heating without injuring the animals housed inside
Temperature Control Capability	20	The infant wildlife needs the temperature to be 95 degrees Fahrenheit with a buffer of 2 degrees. This temperature range is vital to ensure that the infant wildlife are warmed to proper body temperature.
Durability	20	The incubator itself must last 10 years but the electrical components can be replaced infrequently, as needed
Cost	15	The whole incubator must be within $100 per including assembly.
Feasibility	10	Prototyping should represent the actual assembly of the final product, which will be done by employees at the rehabilitation center.
Replaceability	10	The electrical components are easy to replace during the lifetime of the incubator.

Design Matrix

Criteria	Design 1: Feedback Heater with Bed Detection.	Design 2: Feedback heater with Ambient Air Detection	Design 3: Modified Arduino Thermistor
Safety (25)	3/5 (15)	5/5 (25)	4/5(20)
Temperature Control Capability (20)	3/5(12)	4/5 (16)	5/5 (20)
Durability (20)	5/5(20)	4/5(16)	4/5(16)
Cost (15)	2/5(6)	3/5(9)	5/5(15)
Feasibility (10)	4/5(8)	3/5(6)	5/5(10)
Replaceability (10)	3/5(6)	4/5(8)	5/5(10)
Total (100)	67	80	91

Table 2: Temperature Preliminary Design Matrix

Materials

Designs

3D Printing:

- Acrylonitrile Styrene Acrylate (ASA)
- Chlorinated Polyethylene Elastomer (CPE)

Figure 15: Ultimaker S3 3D printer

Figure 16: Example of CPE filament

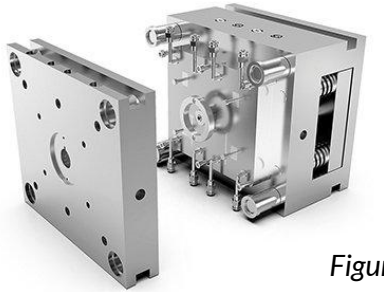


Figure 17: Example of thermoplastic injection mold

Injection Molding:

- Polylactic Acid (PLA)
- Polypropylene (PP)

Figure 18: Sumitomo Injection Molding Machine

Design Matrix Criteria

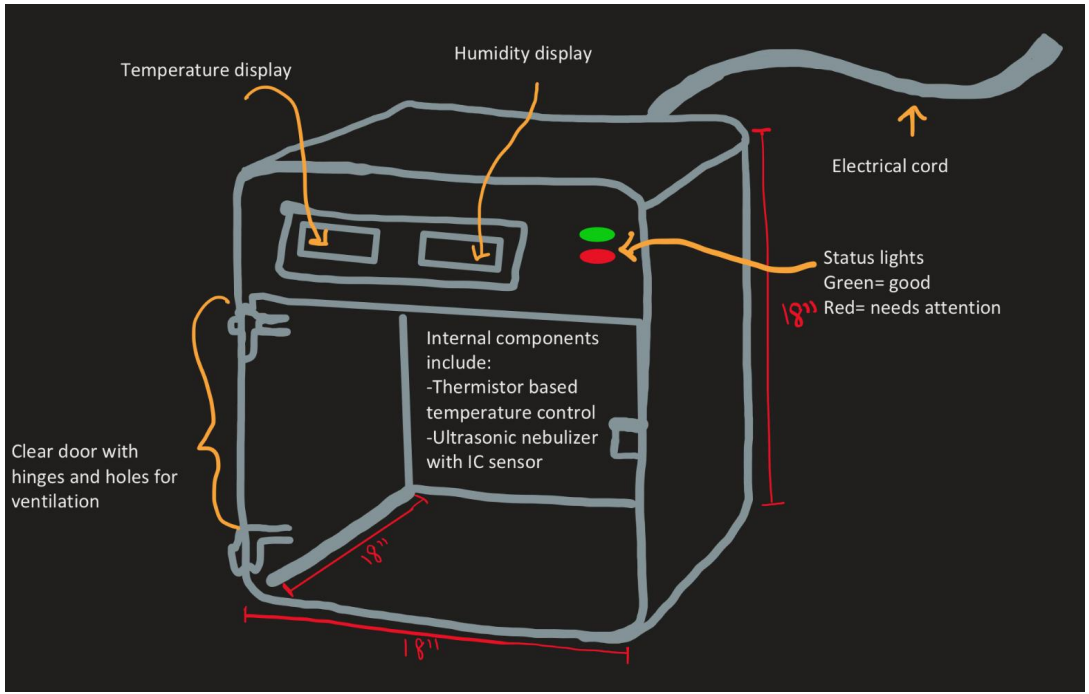
Criteria	Weight	Description
Temperature Support	25	The material must be able to retain heat and resist heat produced by the electronics
Water/Weather Resistance	25	Due to humidity control the apparatus must be resistant to water. This applies more so if it will be stored outdoors.
Strength and Durability	20	The apparatus should be made of sturdy material that is also able to withstand the stresses caused by the incubated wildlife
Cost	15	Since the apparatus is being made for a non-profit organization, it must be affordable
Weight	10	To reduce shipping costs and support the ergonomics of daily use by employees, weight of the apparatus should be minimized
Safety	5	While the apparatus' material won't be dangerous in any way, some materials support antimicrobial applications

Design Matrix

Criteria	Design 1: 3D Printing - ASA	Design 2: 3D Printing - CPE	Design 3: Injection Mold - PLA	Design 4: Injection Mold - PP
Temperature Support (25)	4 (20)	5 (25)	3 (15)	5 (25)
Water/Weather Resistance (25)	5 (25)	4 (20)	2 (10)	4 (20)
Strength/Durability (20)	3 (12)	5 (20)	5 (20)	3 (12)
Cost(15)	5 (15)	2 (6)	4 (12)	3 (9)
Weight (10)	4 (8)	3 (6)	2 (4)	5 (10)
Safety (5)	2 (2)	3 (3)	2 (2)	5 (5)
Total (100)	80	80	63	81

Table 3: Materials Preliminary Design Matrix

Chosen Preliminary Design



Components:

- Design made of injection molded PP
- Temperature and humidity displays from feedback mechanisms
- Lights/alarm to draw attention for issues sensed
- Clear door that allows visibility into the interior
- Holes for ventilation
- Electric power source

Future Work

This semester:

- Assemble multiple iterations for feedback
- Create a prototype and perform testing that can be presented at the conference

Beyond this semester:

- Prioritize low cost
- Improve design based on feedback from conference
- Develop more robust prototype
- Perform testing

Acknowledgements

We would like to thank:

- Dr. Mark Stelford
- Dr. Wally Block
- BME Department

References

[1] “Oaken Acres: Wildlife center,” Oaken Acres | Wildlife Center, https://www.oakenacres.org/index.html (accessed Oct. 1, 2023).

[2] A. Moran, “What is wildlife rehabilitation?,” Urban Utopia Wildlife Rehabilitation, https://www.urbanutopiawildlife.org/wildlife-rehabilitation (accessed Sep. 28, 2023).

[3] “TLC brooders/Intensive Care Units,” /Hospital Cage, https://www.brinsea.com/p-682-tlc-50-zoologica-ii-parrot-brooderintensive-care-unitrecovery-incubator.aspx (accessed Sep. 21, 2023).

[4] “TLC brooders/Intensive Care Units,” Home, https://www.brinsea.com/p-615-tlc-30-eco-parrot-brooderintensive-care-unitrecovery-incubator.aspx (accessed Sep. 21, 2023).

Questions?