Deliverable E: Project Plan and Cost Estimate

GNG 1103 – Engineering Design

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Abstract

This deliverable outlines a project plan for the design, development, and testing of prototypes to be completed by semester's end. It includes a refined design drawing of the chosen concept, a structured schedule for prototyping and testing with task assignments, and contingency plans for identified risks. A detailed Bill of Materials (BOM) and list of required equipment provide clarity on resources, while the prototyping test plan defines objectives, measurable outcomes, and criteria for testing completion. This document will guide the team's structured development and validation of the prototypes.

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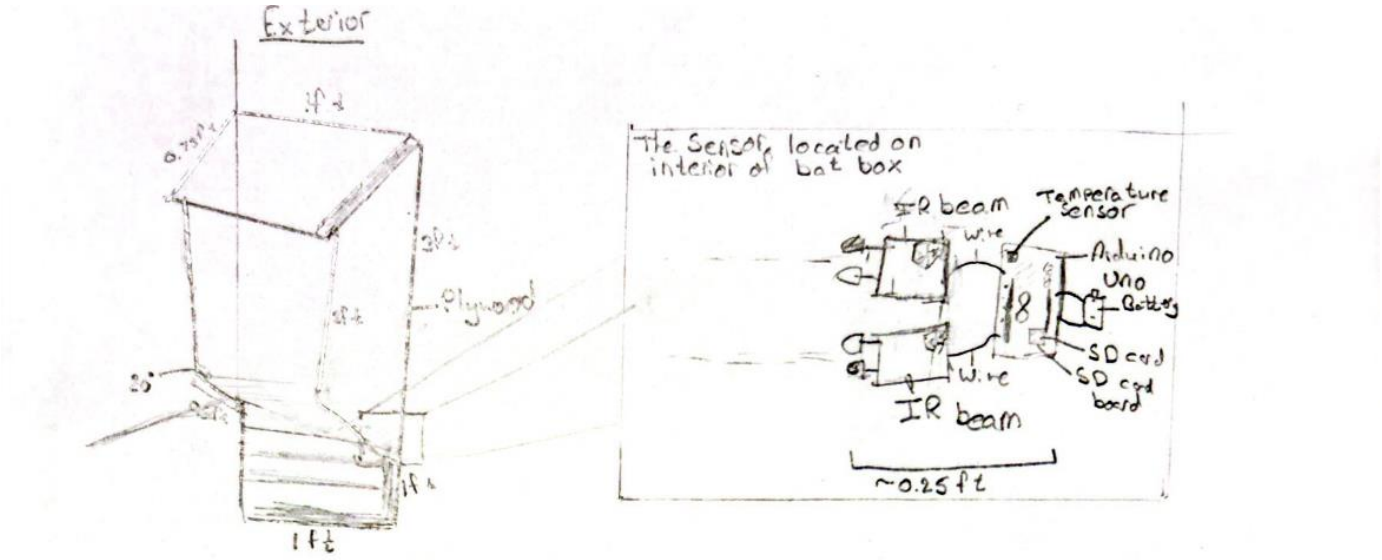
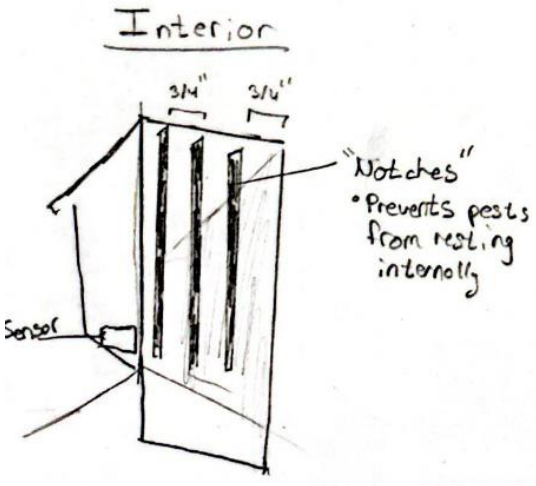
1. Introduction

The problem we aim to solve is the design of a compact, low-cost bat box that tracks bat visits and provides a safe shelter for endangered bats. Our design will ensure a stable internal temperature (around 29°C, with a maximum of 40°C), consistent light levels, and protection from predators. It must be durable enough to last a season, easy to install, and adaptable for use with new and existing bat boxes.

This deliverable outlines the project schedule and budget plan to achieve our design goals within the semester. We also present a prototyping and testing plan to guide iterative development. Emphasizing accessibility and affordability, our solution aims to support bat conservation efforts by providing a practical, sustainable habitat solution for bats in an increasingly challenging environment.

2. Detailed Design Drawing





3. Plan and Schedule for Prototyping and Testing

Task ID	Task Description	Estimated Duration	Assigned To	Task Details
1	Design final prototype drawing	1 Day	Saher Ali and Aidan Eiselt	Create a detailed design drawing of the bat box prototype, including all components and specifications.
2	Research and source materials	1 Day	Cameron Jordan and Mohammad Mohammadi	Identify and source all materials needed, including links and costs for each component in the Bill of Materials.
3	Build Prototype version 1	3 Days	All group members	Assemble the first prototype using the sourced materials and follow the design specifications.
4	Test prototype version 1 for bat count tracking	2 Days	All group members	Monitor and record the testings of the tracking device under various conditions to ensure accurate data collection.
5	Analyze bat count test results	1 Day	All group members	Evaluate data from the bat count tests and identify any necessary adjustments to the tracking system or design.
6	Build prototype version 2 with adjustments	3 Days	All group members	Modify and build the second version of the prototype incorporating adjustments from the first test results.
7	Test prototype version 2 for structural integrity	2 Days	All group members	Subject the second prototype to environmental stresses and document any failures or successes.
8	Analyze structural integrity test results	1 Day	All group members	Review the results from structural tests and outline any further design changes needed.
9	Prepare for final prototype build	1 Day	All group members	Finalize design and confirm all components are sourced and ready for the comprehensive prototype build.
10	Build final prototype	3 Days	All group members	Collaboratively build the final prototype, ensuring all components and design features are included.
11	Conduct comprehensive functionality testing	2 Days	All group members	Test the final prototype for overall functionality, including temperature, durability, and bat entry/access.
12	Analyze functionality test results	2 Days	All group members	Review and evaluate the data from the comprehensive tests, noting areas for improvement and necessary iterations.
13	Prepare presentation and documentation	2 Days	All group members	Compile all test data, designs, and findings into a presentation format for the final submission.

4. Project Risks and Contingency Plans

Risk ID	Description of Risk	Impact	Likelihood	Mitigation/Contingency Plan
1	Delays in sourcing materials	Project timeline extension	Medium	Pre-approve materials and utilize local supplies. Have alternative supplies on standby.
2	Prototype fails to meet temperature requirements	Compromised bat safety	Medium	Adjust design based on testing feedback; ensure a robust monitoring system is in place.
3	Structural failure during testing	Safety risk and redesign needed	Low	Conduct pre-testing assessments and strengthen design where needed. Conduct tests in controlled conditions.
4	Team member availability issues (sickness, etc.)	Delays in task completion	Medium	Crosstrain team members to handle multiple roles; maintain flexibility in task assignments.
5	Inaccurate data collection from sensors or tracking devices	Misleading test results	Medium	Implement calibration checks before testing; conduct preliminary trials to ensure data accuracy.
6	Budget overruns due to unexpected costs	Compromise on materials	Low	Prepare a detailed budget and seek TA approval early; review BOM regularly to manage costs.

5. BOM

Item	Cost of Item	Number of Items	Total cost
IR Break Beam Sensor	2.95	2	5.9
Temperature Sensor	6.04	1	6.04
Lithium Ion Battery	13.3	1	13.3
5ft of Black Wires	1.6	1	1.6
Arduino UNO	15.25	1	15.25
USB Cable	2.75	1	2.75
SD Card	3.8	1	3.8
SD Card Board	3.5	1	3.5
MDF	3	2	6
Nails	5.97	1	5.97
Mounting Brackets	4.97	1	4.97
		Total tracker cost	69.08

Links For Products

https://learn.adafruit.com/ir-breakbeam-sensors/arduino

https://www.amazon.ca/ANALOG-DEVICES-TMP36-Temperature-Sensor/dp/B00JYQAIBM

https://www.amazon.ca/Panasonic-CR123A-Lasting-Lithium-Batteries

https://makerstore.ca/shop/ols/products/5ft-hook-up-wire-22awg-black

https://makerstore.ca/shop/ols/products/arduino-uno-r3-clone

https://makerstore.ca/shop/ols/products/usb-type-a-b-cables

https://www.temu.com/ca/----128mb-512mb-1024mb-2048mb-

https://www.temu.com/ca/20--clear-plastic----for-sd---sd-

https://makerstore.ca/shop/ols/products/mdf/v/M003-1-8-18-NCH

https://www.homedepot.ca/product/paulin-1-1-4-inch-3d-smooth-finishing-nails-bright

https://www.homedepot.ca/product/unbranded-universal-mount-shade-brackets-silver-2-pc

6. List of Equipment

Hardware Components (as per BOM)

- **IR Break Beam Sensor (x2)**

Purpose: Detect objects breaking an infrared beam.

- **Temperature Sensor (x1)**

Purpose: Measure environmental or specific area temperature.

- **USB Battery Pack (x1)**

Purpose: Portable power source for the prototype.

- **5 ft of Black Wires (x1)**

Purpose: Wiring for connections between components.

- **Arduino UNO (x1)**

Purpose: Microcontroller for handling sensors and data.

- **USB Cable (x1)**

Purpose: Connect Arduino to computer for programming and power.

- **SD Card (x1)**

Purpose: Store data collected by Arduino.

- **SD Cardboard (x1)**

Purpose: Interface between the SD card and Arduino for data storage.

- **MDF (Medium-Density Fiberboard)**

Purpose: Primary structural material for building the bat box.

- **Nails**

Purpose: Fasten MDF components securely.

- **Brackets**

Purpose: Reinforce corners and add structural stability to the bat box.

Additional Temporary Materials (for Initial Prototyping)

1. **Breadboard** (not listed in BOM)
    a. Purpose: Quick and flexible prototyping of circuits.
2. **Jumper Wires**
    a. Purpose: Easily connect components on the breadboard.
3. **Resistors** (specific values depend on sensors used)
    a. Purpose: Current limiting and signal adjustments.

Required Software

1. **Arduino IDE**
    a. Purpose: Program Arduino for handling sensor data and storing it on the SD card.
2. **Serial Monitor (in Arduino IDE)**
    a. Purpose: Real-time data monitoring for debugging.
3. **Data Analysis Software** (e.g., Excel, Google Sheets)
    a. Purpose: Analyze data collected on the SD card.

7. Prototyping Test Plan

Test ID	Test Objective (Why)	Description of Prototype and Basic Test Method (What)	Description of Results to be Recorded and Usage (How)	Estimated Test Duration and Planned Start Date (When)
1	Ensure temperature regulation	Use initial prototype with temperature sensors inside bat box; monitor internal temperature under various external conditions.	Record temperature readings at intervals and assess if internal temperature stays between 29°C and 40°C; identify any required insulation adjustments.	Duration: 1 day; Start Date: November 4th
2	Test structural durability	Place prototype in an outdoor environment, with wind, rain, and mild impacts.	Document any wear, damage, or need for reinforcements; results will guide material selection and potential design reinforcements.	Duration: 2 days; Start Date: November 4th
3	Evaluate bat entry accessibility and safety	Use the prototype with an entry sensor; simulate bat entry conditions to test usability of landing and roosting areas.	Record successful and unsuccessful entries; adjust entry design if necessary for safe and effective landing and roosting.	Duration: 1 day; Start Date: November 4th

4	Test data collection accuracy	Install a tracking sensor and data storage system; test by simulating bat entries and exits.	Record and verify bat count accuracy; confirm data logging functionality. Results will confirm sensor and system reliability.	Duration: 1 day; Start Date: November 5th
5	Check predator-proof design	Test entry points with common small animal models or barriers to simulate predator attempts	Record if any entry points allow access; reinforce or modify areas as necessary to improve security.	Duration: 1 day; Start Date: November 5th
6	Validate ease of installation	Test prototype installation using different mounting surfaces and simulate user instructions.	Note installation difficulties, time required, and potential user issues; adjust mounting design or instructions as needed.	Duration: 1 day; Start Date: November 5th
7	Verify overall system integration	Test all components together (temperature control, entry tracking, data logging) in simulated real-use conditions.	Record full system performance; confirm that all subsystems function together as intended and identify any compatibility issues.	Duration: 2 days; Start Date: November 6th
8	Battery life and power supply validation	Test prototype in continuous use with tracking and temperature sensors to monitor power consumption.	Track battery life and power consistency; adjust power supply or battery capacity if necessary.	Duration: 2 days; Start Date: November 4th

7.1 Stopping Criterion

Test ID	Stopping Criterion
1	Stop when 10 consecutive readings show temperatures within the target range.
2	Stop if no damage is observed after 5 days of exposure.
3	Stop when 50 entries have been successfully logged.
4	Stop when 25 entries have been processed with acceptable accuracy.
5	Stop if no breaches are detected after 10 predator attempts.
6	Stop once 2 installations have been completed within the time limit.
7	Stop if all subsystems perform correctly in 3 consecutive tests.
8	Stop once battery life meets or exceeds the 30-day threshold.

8. Conclusion

In this deliverable, we have developed a comprehensive plan for the design, prototyping, and testing of our bat box solution. This project has reinforced the importance of thorough planning and organization in the engineering design process, particularly when addressing the specific needs of endangered bats. Our structured approach to defining tasks, estimating durations, and assigning responsibilities has provided a clear roadmap for our team moving forward.

While we have not yet conducted any testing, the planning phase has highlighted several critical areas for future consideration. We learned that for our prototype to be successful, we must balance functionality, cost-effectiveness, and ease of installation, ensuring that our solution is accessible to a wide range of users.

For our next steps, we recommend focusing on the following areas:

1. **Prototyping Details**: As we move into the prototyping phase, it is essential to ensure that our designs are not only theoretically sound but also practically viable. Continued refinement of our design drawings and BOM will facilitate a smoother transition to building our prototypes.
2. **Iterative Improvements**: Following an agile methodology, we must remain open to feedback and willing to iterate on our designs. This adaptability will be vital in addressing any unforeseen challenges during the prototyping process.
3. **Risk Mitigation**: As we move forward, it is essential to continuously identify and evaluate project risks. Developing contingency plans will help us address potential setbacks proactively.

By focusing on these areas in our future work, we can enhance the effectiveness of our bat box prototype and contribute meaningfully to bat conservation efforts. The planning and insights gained from this phase will serve as a solid foundation as we embark on the prototyping and testing stages of our project.