Faculty of Engineering

University of Ottawa

GNG 1103 C04 – Engineering Design

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Project Deliverable E: Project Plan and Cost Estimate

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Abstract

This deliverable will display the cost estimates, the bill of materials required, and the project plan to complete all project prototypes by the end of the semester. It will keep the project on track within the allocated budget and timeline.

Table of Contents

1 Introduction

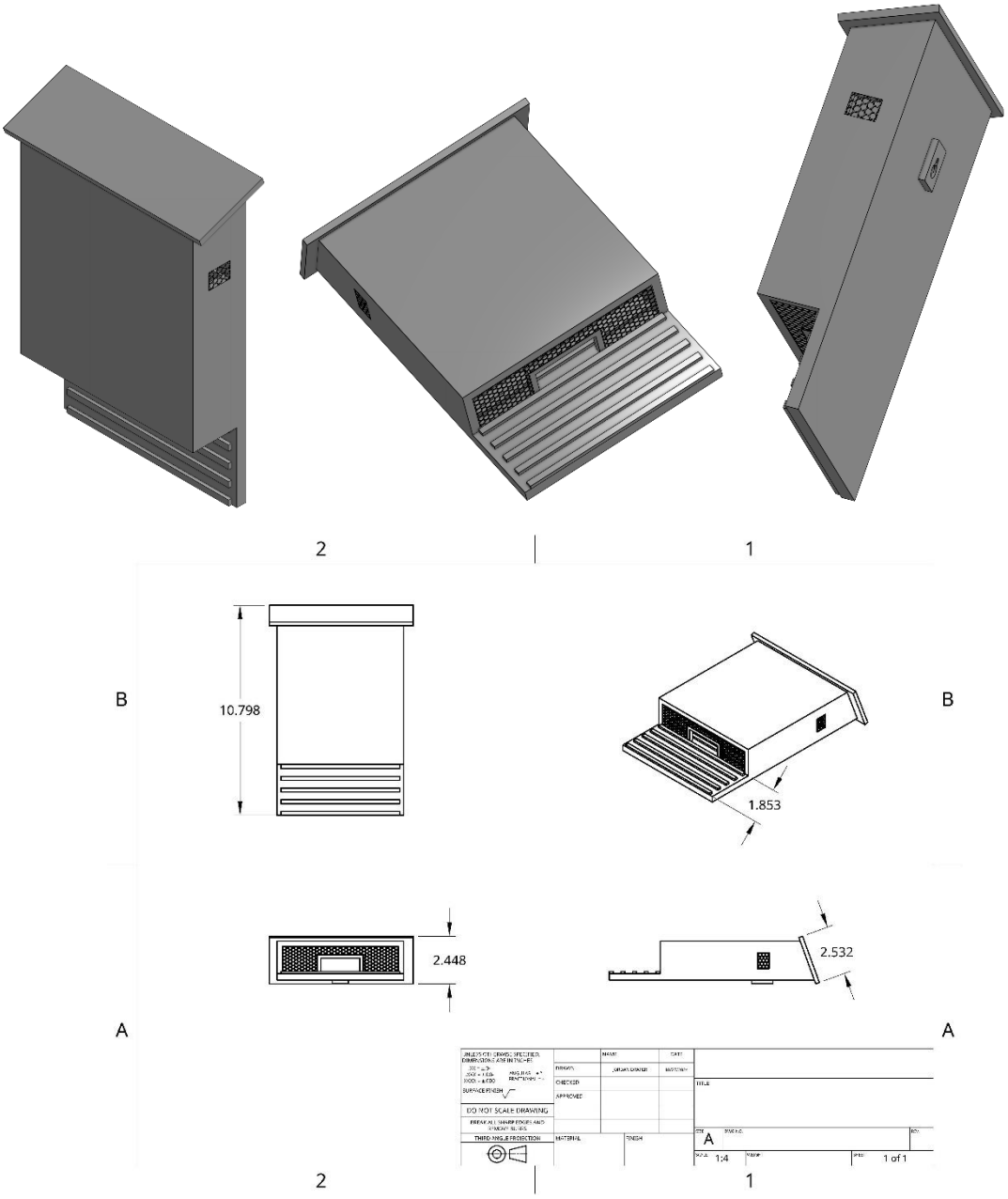
We will start, our technical report, by providing a detailed design of our best conceptual design. Then we will detail our project plan, bill of materials, and prototype test plan and discuss potential risks and their solutions. At the end, we will talk about our typical objectives and stopping criteria. Thus, with that approach, we will help bat conservationists in Canada to see the effectiveness of the bat boxes.

2 Detailed Designs

In this part, we are going to divide the bat box design into three subsystems and to sketch each subsystem a detailed design. From these subsystems, we will build our design that will track bat visits to that box and will help bat conservationists to see the efficacity of that box.

2.1 Bat Box Structure

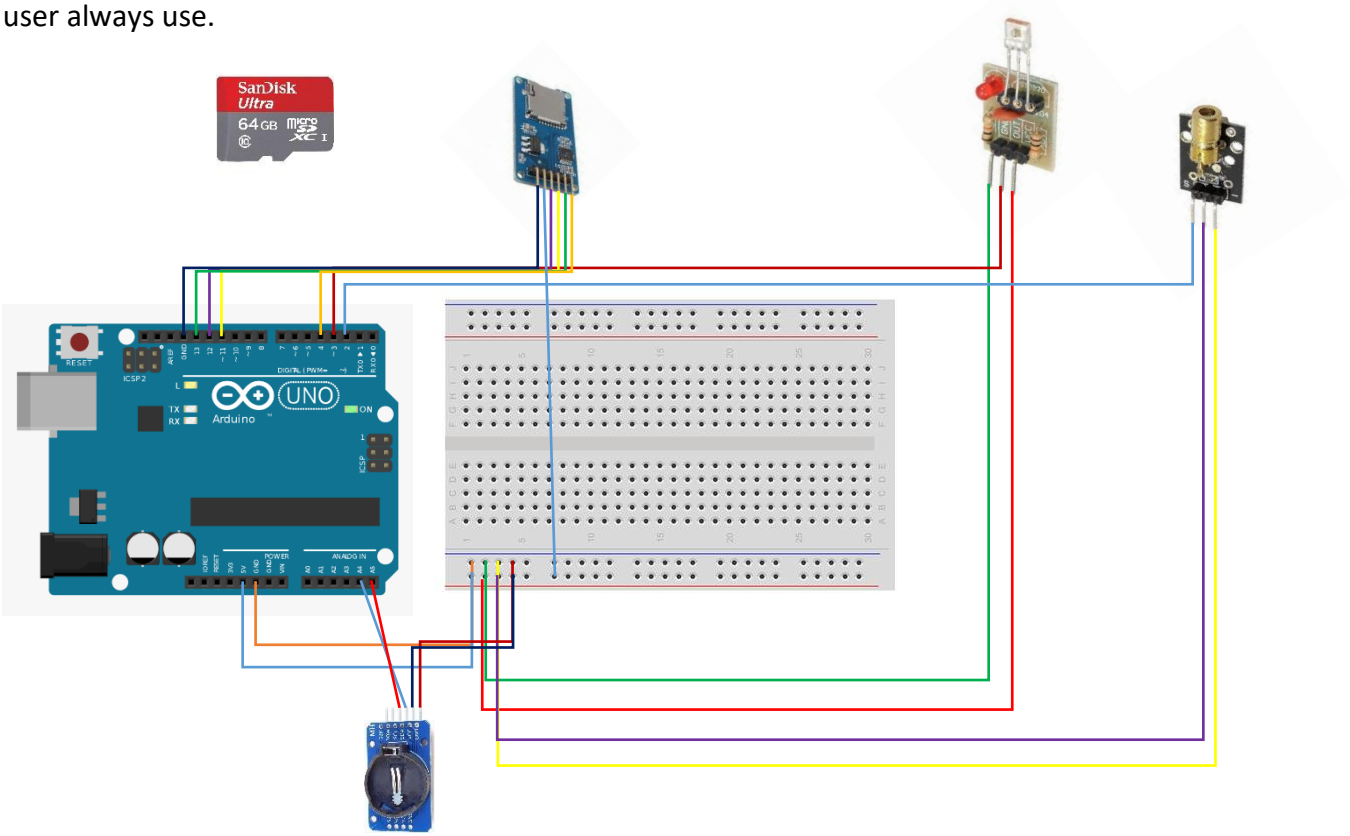
This subsystem, bat box structure, needs to be designed to give those bats a home that considers their safety, comfort, and health and withstands any change in weather.



This design is a preliminary 3D model which aims to incorporate the most desirable features of the bat box such as climbing kerfs, ventilation holes, and bottom meshing. The 3D model's dimensions have not been finalized and it has not been fitted with assembly joints yet.

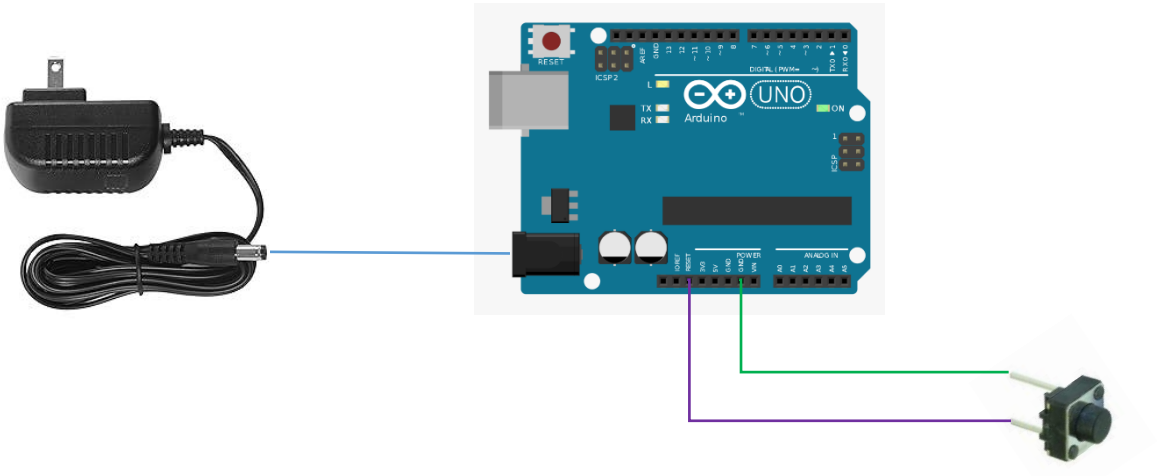
2.2 Tracking Device

This subsystem, the tracking device, needs to be designed to count the number of bats using this bat box. These data can be stored in a device or transferred to a device that this user always use.



2.3 Power and Coding Functionality

The last subsystem, power and coding functionality, ensures that our tracking device has electricity to function and works autonomously without relying on a computer. It also has a reset button to reset data from the start.



```ino
#include <SPI.h>
#include <SD.h>
#include <Wire.h>
#include <RTClib.h>

const int laserReceiverPin = 3;  // Pin connected to the Laser Receiver OUT
const int chipSelect = 4;        // Pin connected to the SD card's chip select (CS)

int batCount = 0;  // Variable to store the number of bats counted
bool lastLaserState = HIGH;  // Variable to track the last state of the laser receiver
bool currentLaserState = HIGH;

File dataFile;
RTC_DS3231 rtc; // Create an RTC object

void setup() {
  Serial.begin(9600);
  pinMode(laserReceiverPin, INPUT);

  // Initialize the SD card
  if (!SD.begin(chipSelect)) {
    Serial.println("SD card initialization failed!");
    return;
  }
  Serial.println("SD card initialized.");

  // Initialize the RTC
  if (!rtc.begin()) {
    Serial.println("Couldn't find RTC");
    while (1);
  }

  // Set the RTC time (uncomment to set the time, do this only once)
  // rtc.adjust(DateTime(F(__DATE__), F(__TIME__)));

  Serial.println("RTC initialized.");
}

void loop() {
  currentLaserState = digitalRead(laserReceiverPin);

  // Detect when the laser beam is interrupted (bat passes)
  if (lastLaserState == HIGH && currentLaserState == LOW) {
    batCount++;
    Serial.print("Bat count: ");
    Serial.println(batCount);
  }

  // Get the current time from the RTC
  DateTime now = rtc.now();

  // Check if a day has passed
  static DateTime lastDay = now; // Store last recorded day
  if (now.day() != lastDay.day() || now.month() != lastDay.month() || now.year() != lastDay.year()) {
    // Write bat count to SD card
    dataFile = SD.open("batCount.txt", FILE_WRITE);
    if (dataFile) {
      dataFile.print("Bat count for ");
      dataFile.print(now.year());
      dataFile.print("-");
      dataFile.print(now.month());
      dataFile.print("-");
      dataFile.println(now.day());
      dataFile.println(batCount);
      dataFile.close();
    } else {
      Serial.println("Error opening batCount.txt");
    }

    // Reset for the next day
    batCount = 0; // Reset bat count
    lastDay = now; // Update last recorded day
  }

  lastLaserState = currentLaserState;

  // Small delay to avoid excessive reads
  delay(50);
}

```

3 Project Plan and Schedule

Table 1: Project Plan and Schedule

ID	Task Description	Dependencies	Owner	Duration	Due Date
1	Deliverable D	None	All	10 days	10/17/2024
2	Client Meeting 2	None	All	None	10/22/2024
3	Design Review	1	All	1 day	10/24/2024
4	Deliverable E	1,2	All	10 days	10/27/2024
5	Build Prototype 1	2,3	All	1 day	10/31/2024
6	Deliverable F	4	All	7 days	11/03/2024
7	Client Meeting 3	2,4	All	None	11/05/2024
8	Iterative Prototyping Part 1 (Prototype 2)	4,6	All	1 day	11/07/2024
9	Deliverable G	7	All	7 days	11/10/2024
10	Iterative Prototyping Part 2 (Prototype 3)	7	All	1 day	11/14/2024
11	Iterative Prototyping Part 2 (Prototype 3)	9	All	1 day	11/21/2024
12	Deliverable H	8,9,10	All	7 days	11/24/2024
13	Deliverable I	12	All	3 days	11/27/2024
14	Design Day	13	All	1 day	11/28/2024
15	Client Meeting 4	14	All	1 day	11/28/2024
16	Deliverable J	13	All	4 days	11/28/2024
17	Deliverable K	14	All	7 days	12/02/2024

4 Bill of Materials

Table 2: Bill of Materials

Parts	Quantity	Unit of Measure	Unit Cost ($)	Estimate Cost ($)	Link
Hardware Required					
¾" MDF Sheet	1	inches	56.99	56.99	Link Sections
8 oz. Black Waterproofing Stain	1	ounce	5.98	5.98	Link Sections
Electrical Components Required					
Arduino Uno	1	EA	9	9	Link Sections
Breadboard	1	EA	2.5	2.5	Link Sections
Laser Donner Sensor	1	EA	1.99	1.99	Link Sections
Laser Receiver Sensor	1	EA	2	2	Link Sections
MicroSD card Adapter	1	EA	2.5	2.5	Link Sections
MicroSD card	1	EA	7	7	Link Sections
DS3231 RTC Module	1	EA	2.99	2.99	Link Sections
Power Supply Adapter	1	EA	13.99	13.99	Link Sections
Push Button	1	EA	0.54	0.54	Link Sections
Jumper Wires	20	EA	0.1	2.0	Link Sections
Software Required					
OnShape	1	EA	0	0	Owned
Trello	1	EA	0	0	Owned
Arduino IDE	1	EA	0	0	Owned
Libraries					
SPI	1	EA	0	0	Link Sections
SD	1	EA	0	0	Link Sections
Wire	1	EA	0	0	Link Sections
RTClib	1	EA	0	0	Link Sections
Total Cost (Without Taxes)				107.48	
Total Cost (With Taxes)				121.45	

5 Project Risks

This section will present different risks that we would probably encounter when developing our design. To tackle these risks, we have categorized them according to their probability of occurring and have written solutions depending on the level of risk.

Risks	Probability of Occurring	Level of Risk	Solutions
Coding non-functionable	High	Moderate	Ask the TA/PM for help or break the code into smaller parts and then test incrementally
Circuit Complexity	High	Moderate	Ask the TA/PM for help or divide the circuit into smaller circuits
Bat Box Assembly	Low	Moderate	Repeat from the beginning and then follow the details and instructions on how to assemble
Time Management	Medium	Moderate	Organizing and planning our tasks depending on our Project Plan and using Trello
Conflicts between Members	Low	Moderate	Foster open communications, solve issues as early as possible before it continues. If not, ask for help from TA/PM

6 Typical Objectives

The objectives for this bat box project include addressing client feedback, ensuring subsystem functionality, verifying design feasibility, and reducing maintenance requirements. Based on the client's input, the entry/exit mechanism must always remain open, ensuring that bats can move freely. This change minimizes maintenance requirements and reduces the risk of obstructing bat movement or impacting tracking accuracy. Another objective is the inclusion of a mesh-emptying solution, proposed as a drawer system that allows easy access for cleaning without disturbing the bats. This reduces the risk of the mesh filling up, which could hinder bat movement or interfere with data collection.

The design's flexibility and feasibility are also prioritized, particularly in the mountable roof, which, while not a primary concern for the client, may require testing in various mounting environments, such as on trees or other structures, to ensure reliability. Testing for ease of access in the drawer system is also planned to ensure it meets the project's minimal maintenance goals. These objectives work together to create a durable, low-maintenance bat box that meets client specifications and environmental needs.

7 Prototype Test Plan

Table 3: Prototype Test Plan

ID	Test Objective	Description of Prototype	Results to be Recorded	Duration of Test
1	Determine if bat box is effective	Test and observe the temperature within the bat box to ensure it is suitable for bats, and also test how the bat box may be affected by weather such as snow. Snow will be put on the roof of the bat box to test how it handles that type of weather.	-The temperature within the bat box to ensure it is safe for the bats inside -Check to see if the bat box can support the weight of snow buildup (Surface area of the roof times height typical snowfall times density of snow)	45 minutes
2	Determine if the coding is functional	Have the Arduino ide code on a laptop connected to what is needed to track visits, and simulate an entry and exit	If the code gives the proper and accurate number of entry/exits that were simulated.	10 minutes
3	Determine if laser sensor is working	Simulate entry and exiting from the bat box using a prop for a given number of times.	The Arduino will record the number of times the laser beam's sensor detects an object at the bat box's entry. Verify that the sensor has accurately recorded the number of entries.	5 minutes
4	Determine if SD card stores data	Simulate visits and plug card into computer and check stored data, also simulate a power outage to see how SD card reacts, also test to ensure that stored data stays the same after you remove the SD card and re insert it into the bat box	Record if SD card stores data correctly, that it can properly operate before and after a power outage, and if SD card keeps data even after it gets removed from the box and re inserted.	45 minutes
5	Determine if battery aliments Arduino Uno	Simulate visits to bat box, and observe if the code is updating the simulated visits properly, if so than that shows the battery is powering the Arduino uno	If the coding setup is running properly, and the Arduino uno is providing the correct input for the code, we can assume the battery is properly powering the Arduino Uno.	15 minutes
6	Determine if the reset button is working	Simulate visits to the bat box, and then press reset button	If the number of visits goes from its original number back to 0 after the reset button is pressed	5 minutes

8 Stopping Criteria

Test	Stopping Criterion
1	The test can be stopped once the snow (10-15 cm to simulate a typical heavy snowfall) has been put on the roof and the temperature, as well as any structural deformations, have been recorded
2	The test can be stopped once a bat entry and exit has been simulated and the code has been observed to be either functioning properly or not
3	The test can be stopped once the given number of entries and exits has been simulated and the laser sensor has been observed to either accurately recorded the number or entries and exits or not
4	The first component of the test can be stopped once the given number of entries and exits have been recorded and the SD card has been observed to be either storing data correctly or not. The second component can be stopped once a power outage has been simulated and the SD card has been tested for functionality. The third component can be stopped once the SD card has been removed from the bat box, reinserted, then tested for functionality
5	The test can be stopped once an entry and exit has been simulated and the code/battery have been observed to either be powered and functioning properly or not
6	The test can be stopped once the reset button has been pressed and the results have been observed.
7	The test can be stopped once we run out of time.

9 Conclusion

In conclusion, we outlined our project plan, our required bill of materials and our prototype test plan and spoke about potential risks that might arise as we progress and solutions for each risk. In addition, we have sketched a detailed design of our best conceptual design and provided our typical objectives.

10 Link Sections

Hardware:

Bat Box Structure CAD:

https://cad.onshape.com/documents/cf85593d9314c67186a69158/w/261c4abd28dc68f89aa972f0/e/e67d684057078f74b29aa4f6

¾" MDF Sheet:

https://www.rona.ca/en/product/3-4-in-x-49-in-x-97-in-mdf-panel-bm003056-49585309

8 oz. Black Waterproofing Stain

https://www.homedepot.com/p/BEHR-PREMIUM-1-qt-SC-102-Slate-Solid-Color-Waterproofing-Exterior-Wood-Stain-and-Sealer-501304/310902631

Electrical Components:

Arduino Uno:

https://edu-makerlab.odoo.com/shop/arduino-1930?search=arduino&order=name+asc#attr=378

Breadboard:

https://edu-makerlab.odoo.com/shop/breadboard-2102#attr=880

Laser Donner and Receiver Sensor:

DAOKI 4PCS Laser Sensor Module Non-Modulator Tube Laser Receiver Module for Arduino with 4PCS KY-008 650nm Laser Transmitter Module, Dupont Cable : Amazon.ca: Tools & Home Improvement

MicroSD Card Adapter:

https://edu-makerlab.odoo.com/shop/microsd-adaptor-2168?search=microsd+card

MicroSD Card:

https://edu-makerlab.odoo.com/shop/micro-sd-card-2166#attr=1061

DS3231 RTC Module:

CANADUINO® DS3231 RTC Module, 32kB Memory, I2C Interface, Battery Backup : Amazon.ca: Electronics

Power Supply Adapter:

Security-01 9V 1A Power Supply Adapter, DC Jack Center Positive, Plug 5.5mm x 2.1mm,for Arduino UNO, Nixie Tube Clock, Schwinn Elliptical Machine and More,6.8FT Cord, UL Listed : Amazon.ca: Industrial & Scientific

Push Button Switch:

https://edu-makerlab.odoo.com/shop/push-button-switch-2198#attr=1126

Jumper Wires:

https://edu-makerlab.odoo.com/shop/jumper-wires-2154#attr=1040

Libraries:

SPI: https://docs.arduino.cc/learn/communication/spi/

SD: https://docs.arduino.cc/libraries/sd/

Wire: https://docs.arduino.cc/language-reference/en/functions/communication/Wire/

RTClib: https://reference.arduino.cc/reference/en/libraries/rtclib/

11 References

1. Laser Donner Sensor Image: https://ph-test-11.slatic.net/p/dcd1078278d69a71111df90c7b889a35.jpg
2. Laser Receiver Sensor Image: https://www.tinytronics.nl/shop/image/cache/data/product-1061/laser%20receiver%20module-600x600.jpg
3. Breadboard Image: https://www.shutterstock.com/image-vector/half-breadboard-vector-illustration-providing-600nw-2306585395.jpg
4. Arduino Uno Image: https://www.pngitem.com/pimgs/m/14-146612_arduino-uno-vector-png-transparent-png.png
5. MicroSD Card Adapter Image: https://store.nerokas.co.ke/image/cache/catalog/MicroSD%20module-500x500.JPG
6. MicroSD Card Image: https://www.bhphotovideo.com/images/images2000x2000/sandisk_sdsqunc_064g_an6ia_sandisk_1170203.jpg
7. DS3231 RTC Module: https://m.media-amazon.com/images/I/61jIFJRna4L._AC_SL1333_.jpg
8. Power Supply Adapter: https://m.media-amazon.com/images/S/aplus-media-library-service-media/e7062853-0fb1-43a7-a0b8-0aa87483312c.__CR0,0,1600,1600_PT0_SX300_V1___.jpg
9. Push Button: https://th.bing.com/th/id/OIP.LL_TiS5naraLfQ7KDedDngHaF9?pid=ImgDet&w=171&h=137&c=7&dpr=2.2