Introduction:

Developing a sensor system to monitor bat activity within bat boxes is critical for achieving Tiree's objective of encouraging healthy bat populations. This document delineates the primary goals of the project, emphasizing the necessity for a sensor that is precise, strong, resistant to weather conditions, and economically feasible, while ensuring it does not hinder bat movement. Each aspect of the design is assigned a priority rating, with essential functions such as accurately recording the number of bat visits (rated 5), guaranteeing a battery life of at least one month (rated 5), and providing weather resistance (rated 4) being important for the overall dependability and low maintenance of the system. These priorities have been thoughtfully selected to guarantee that the sensor is practical for widespread implementation, reliable over time, and easy to maintain.

**Design Criteria for Bat Monitoring System**

1. **Accurate Tracking of Bat Visits** : Ability to record the number of visits with accuracy and shouldn't be offset by another type of animal (should determine what % of error is permitted)

2. **Non-intrusive** Should not impede natural bat movement or behavior, allowing for swift entry and exit. If a sensor needs some form of light to function actions need to be taken to make sure the bats are not sensitive to it

3. **Elevated Installation (box)**: Should be designed to be installed 5-8 feet off the ground to avoid ground predators but also to replicate as closely as possible normal bat habitat to encourage usage
   **Landing Pad (box)**: Must include a landing pad of at least 1.5ft to facilitate bat landing.

4. **Weatherproof Design:** essential to the proper functioning of the sensor and allowing for the one season durability criteria which is the critical part of the project since the box will be exposed to direct sunlight (for 6-8h) during the summer the sensor must not be deteriorate by rays or by high temperatures but also it must be rainproof so maybe the sensor will be in some form of box to protect it from elements.

5. **Minimal maintenance :** The battery life must hold for a month and shouldn't require other maintenance often (cleaning etc)

6. **Multi-occupancy** : Dimensions should allow multiple bats to occupy since they have a habit of roosting together. The dimensions must allow at least one bat species to be accommodated. 24" x 16" x 5" could provide sufficient space. It will be scaled down (% to be determined)

**Constraints**

1. **Budget**: Must stay within the budget (50-150) for materials and manufacturing.

2. **Dimensions**: The box and sensor must not be bulky for ease of installation and practical usage
3. **Materials**: Wood is preferred  for the box and it can't guarantee the sensor will stay intact

Meeting with our client, Tiree Inc, allowed our design team to empathize with their specific desires for the requested product. It was made clear that reliably tracking the usage of their bat boxes from April to October is the highest priority. We were also provided with unique information regarding bat behaviours and their interactions with the bat boxes. From this information we derived a list of design criteria that are specific requirements that allow us to satisfy our identified needs.

Since Deliverable B and our client meeting, we have had an impact on our design criteria as we updated the priority of tracking accuracy, non-intrusiveness, and weatherproofing. Topics such as minimizing false readings, sensor designs (light considerations), and weatherproofing were highlighted and reinforced as a necessity due to the environmental exposure. Needs that have been updated based on client input have been the calibration of tracking sensors to avoid errors, design adjustments ensuring the light does not affect bat behavior, a replication of the bat habitat implemented, as well as scaling and protection of the sensor in the box. This deliverable we have reaffirmed multi-occupancy and landing pad dimensions, while adjusting slight changes in budget and material durability.

Conclusion:

To summarize, the design of the bat sensor system must strike a balance between accuracy, durability, and cost-efficiency while remaining non-intrusive to bat behavior. The primary function of the sensor is to accurately track the number of visits, achieving a high accuracy rating of 5, and to guarantee an extended battery life, also rated at 5. This design will ensure reliable performance with minimal maintenance requirements. Additional features, such as weatherproofing and mechanisms to prevent interference with bat movement, are rated at 4 and further contribute to the system's usability and effectiveness. The implications of this design are substantial, as it not only supports the objective of monitoring and promoting healthy bat populations, but also addresses essential considerations such as durability, ease of installation, and cost constraints, thereby making the system scalable for widespread adoption. The careful prioritization of features guarantees that the sensor system is sufficiently strong to endure environmental challenges, while also being affordable and effective for long-term bat conservation efforts. By emphasizing these priorities, the project effectively aligns with Tiree's conservation objectives while providing a reliable and low-maintenance solution for monitoring bat activity.

Source for box dimensions: https://www.batcon.org/about-bats/bat-gardens-houses/