Project Deliverable C:

Design Criteria and Target Specifications

GNG 1103C

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Group 15

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Introduction

In Deliverable B, the interpreted needs of the users were compiled and ranked by relative importance. Deliverable C aims to define a list of prioritized design criteria based on these

needs. These criteria are refined descriptions of the aforementioned needs that can be then turned into both functional and non-functional requirements. The requirements have all been associated to a (or many) design criteria with a set priority. To fully understand the market and the design criteria of the product, technical benchmarking was done for both the bat box and the sensor, allowing an identification of the ideal metrics for the criteria. The objective of both the benchmarking and the prioritized design criteria is to create a collection of technical specifications that will serve to center the product and help create a clear set of metrics based on existing values (ex: technical benchmarking for products already in market) or the team's research for the prioritized design criteria. The specifications will vary between ideal and acceptable values in order to create a realistic framework that leaves room for adaptations and creative design. In short, the objective of this document is to build off the list of needs in Deliverable B and the benchmarking research to create a list of technical requirements that will guide the project and allow the team to develop a competitive and efficient final solution to the design problem.

Prioritized Design Criteria

Requirement	Design Criteria	Priority
Box is a suitable temperature, dry, dark, and safe roost site under the conditions of southern Ontario between April and October.	Internal temperature, Internal light levels, Insulation Operating conditions: Temperature Operating conditions: wind Operating conditions: rain Weatherproofing	4
Device cannot interfere with bat roosting or structural stability of bat house.	Opening Size, Internal light levels, Mounting mechanism of device,	4
Box has an open space below with grippy panel for bat access.	Opening Size, Lower Panel Material	5
Device can estimate bat house usage accurately and robustly.	Data Uncertainty/Error, Documentation	5
Device can also check other data (time, temperature, etc.)	Variety of data output	2
Data collected is organized in a way that can easily be analyzed.	User UI, Data formatting, Documentation	2
Clear identification of what is being tracked.	Documentation	4
Requires minimal maintenance at most once per month.	Battery life Mounting mechanism of box Shell material Excrement chute	3
Is easily installable and has its data accessible by non-engineers (users).	Installation Time, User UI	3
Device can be installable onto existing bat boxes of varying sizes.	Mounting mechanism of device	3
Has a way to inspect whether bats are present in box.	Variety of data outputs Viewing apparatus	2
Is affordable to scale.	Cost	3
Can survive the conditions of being near bats and being in southern Ontario between April and October without needing to be replaced or repaired.	Shell material, Operating conditions: temperature, Operating conditions: wind, Operating conditions: rain, Weatherproofing Mounting mechanism of box Supported weight	3
Box is scalable for larger and smaller designs.	Cost, Manufacturing Complexity	1

Box and device have a long lifespan (10+ years).	Shell material Operating conditions: temperature, Operating conditions: wind, Operating conditions: rain, Weatherproofing Mounting mechanism of box Mounting mechanism of device Supported weight	2

Technical Benchmarking

Sensors

/	**HC-SR501 PIR**	**HC-SR04**	**GP2Y0A51SK0F**
Brand	Stemedu	UNIVERSAL-SOLDER	Sharp Global
Detects	Motion based on heat	Interference	Interference
Wavelength	**Passive IR**	**Ultrasound**	**Active IR**
Power Usage	65mA*5V	2.8mA*5V	12mA*5V
Range	3 metres –7 metres	2cm-500cm	2cm-15cm
Size	32mmx23mmx28mm	45mmx15mmx20mm	27mmx10.8mmx12 mm
Cost	$18 CAD / 5 parts	$13 CAD / 5 parts	$21 CAD / 2 parts
Mass	12grams	8.5grams	2.7grams

Having discussed and compared the above sensors, the team plans to use the **GP2Y0A51SK0F** Active IR sensor. Depending on the power and battery capacity of the design, other sensors may be added for extra measurements.

Bat Boxes

	Pole Mounted Maternity Bat Box	Colony Lodge 4 Chamber	Cedar triple Chamber Bat House
Brand	NHBS	Bat Conservation & Management	Nature's Way
Size	13 x 26 x 49 cm	18" x 24" x 5.75"	12" x 20 1/2" x 5"
Mass	6.6 kg	20lbs	61lbs
Cost	$396.83	$265.00	$78.99
Material	Exterior grade FSC plywood	Thick plastic outer shell	Insect and rot resistant premium cedar
Installation	Pole mounted Rail/screw/clip fixing system	Mount/wood surface	Pole mount Flush mount
Construction	Panels stapled together with surface sunk staple	Highly durable weatherproof body Seamless exterior shell	Stainless steel screws (rust free)
Temperature Control	Internal ceramic plates	Custom bat-shaped front and vertical rear vents for air transfer	Front and side air vents
Accessibility and mobility	Bat ladder	Interior surfaces permanently roughened	Landing kerfs Durable nylon mesh
Maintenance	Removable roof secured with one screw	Self-cleaning, all droppings fall out naturally	Removable inserts

Target Specifications

Design Specification	Relation	Value	Units	Verification Method
Functional Requirements				
Opening Size	>	3/4	inch	Design
Bat is able to grasp lower panel	=	Yes	N/A	Research
Height of box	=	5 to 8	feet	Design
Roof Slope	<	40	°	Design
Internal Temperature	≈	32	°C	Test
Internal Light Levels	<	1	Lux	Test

Device Installation Time	<	1	h	Test
Box Installation Time	<	1	h	Test
User UI	=	Yes	N/A	Design Test Feedback
Data Formatting	=	1	Count/ Entry or exit	Design
Documentation	=	Readable	N/A	Feedback
Insulation	=	Yes	N/A	Research
Weight supported	>	4	kg	FEAs (Factor of safety > 2)
Weatherproofing	=	Yes	N/A	Research
Mounting mechanism of device	=	Yes	N/A	Design
Mounting mechanism of box	=	Yes	N/A	Design
Excrement chute	=	Yes	N/A	Design
Viewing apparatus	=	Yes	N/A	Design
Non-Functional Requirements				
Product Life	>	10	years	Research
Time between maintenance	>	1	months	Research
Variety of Data Output	=	Yes	N/A	Design Test
Battery Life	>	4	hours	Research/Test
Manufacturing Complexity	=	Beginner	N/A	Design Test Feedback
Constraints				
Cost	<	150	$ CAD	Budgeting
Weight	<	6	kg	SolidWorks (estimate) Test (actual)
Electronics Operating Temp.	=	-10 to 60	°C	
Operating Voltage	=	5	V	Design
Operating conditions: temperature	=	2 to 25	°C	Test
Operating conditions: wind	>	13	Km/h	FEAs (Factor of safety > 2)
Operating conditions: rain	<	190	Mm/ Month	Research Test

Conclusions

The initial client meeting gave the project direction with some design specifications that had to be met which helped us form some general ideas. The inquiry from the client was open-ended, so a lot of the specifics of the project were decided based on the team's judgement. It was clear that the sensor being functional and consistent and the bat box being dark and accessible for bats were non-negotiable specifications. We chose our sensor because active IR is not visible to bats and provides consistent data. Our other main option for the sensor was an ultrasound-based laser, which we thought might be intrusive or agitational for bats because they see with echolocation. For our design criteria, aspects that were specifically mentioned as important by the client were ranked a 5 priority, while other things that were needed but not mentioned specifically were given a 4 priority. There are not any needs that were changed or added going from deliverable B to C. Overall, the first client meeting gave us some initial ideas for the design of the sensor and box and gave us some insight into the purpose of the sensor and the goals of the client. This understanding of what the client is looking for in a design will help us make decisions later on in the process and will lead to a product the client is happy with.