Project Deliverable Report Instructions

This document is a template for the project deliverable submissions. Your group will edit this document all semester and submit it each time you have an updated section (new deliverable is done). Please keep track changes ON so that the TA can see what has been changed every time it gets submitted.

Template conventions:

- Remove all red text, it is only there to guide you
- Remove this page (instructions)
- Replace all instances of <xxx> with the appropriate information for your group, for example you could replace <GROUP NUMBER> by ‘B1.3’

GNG2101

Design Project Progress Update

GROUP NAME, B4.1

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List of Acronyms and Glossary

Provide a list of acronyms and associated literal translations used within the document. List the acronyms in alphabetical order using a tabular format as depicted below.

Table 1. Acronyms

Acronym	Definition

Provide clear and concise definitions for terms used in this document that may be unfamiliar to readers of the document. Terms are to be listed in alphabetical order.

Table 2. Glossary

Term	Acronym	Definition

1 Introduction

As a project for our GNG2101 class, we were asked to work as a team to satisfy the needs of a certain client. In our case, the client in question is handicapped and benefits from the use of a wheelchair. Being a dog owner, they would like to interact with their pet in more ways, but they are unfortunately limited because of their condition. Therefore, we are tasked with creating an accessible treat dispenser that can be mounted to any wheelchair and placed on the ground. This document contains every deliverable we will complete for the project and include all relevant information about our product and our business plan. With this document, the progress of our project can be tracked adequately, and any changes to previous deliverables can quickly be made. During this endeavor, we will continuously meet with the client to gain relevant information and use resources provided by the university to respond to their needs.

2 Business Model Canvas and DFX

2.1 Business model and sustainability report

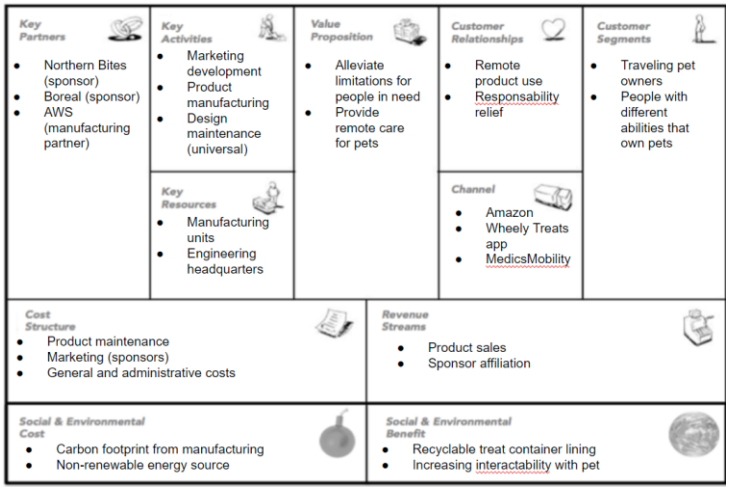
2.1.1 Value proposition

Here at “Wheelie Treats” we aim to make enjoying your time with your furry friends accessible to everyone. Our innovative device attaches to your wheelchair and lets you give your pets a treat with voice activation, the use of an app and at the push of a button. It can be used anywhere in the house by voice activation compatible with multiple languages which will make giving your pets treats no more of a hassle. The “Wheelie Treats” are easy to use, refill and clean with its easily detachable compartments and quick refill system. The dispenser also comes with a variety of treat options to suit your pet’s preferences and dietary needs. Our product connects universally to any wheelchair out on the market right now. It also has the dual function to be placed on a table and the floor. Whether you’re at home, or on the go, the “Wheelie Treats” dispenser makes bonding with your pet fun and convenient.

Reasons for our choice:

- We wanted to capture the attention of our target audience by addressing the main point for the product and offering a solution. To achieve this, we used imperative verbs such as enjoy.
- We wanted to generate interest by highlighting benefits, features and key elements of the product.
- We tried to create desire by emphasizing the outcome of the product.
- We tried to increase accessibility by making the product universal.

2.1.2 Business model canvas



2.1.3 Core assumptions

We assume that our client prioritizes accessibility and reliability over cost. Due to this assumption, we plan to create a compact and efficient device with universal accessibility to unburden some of the responsibilities that come with owning a pet. This product is currently structured upon the assumption of accessibility and conveniency, with continuous design manipulation. Our product is designed to satisfy all pet owners, including frequent travelers and forgetful owners burdened with cognitive impairments (Alzheimer's).

2.1.4 Sustainability report

We at "Wheelie Treats" aim to minimize our manufacturing carbon footprint. We plan to achieve this by using sustainable materials, try to keep our factories clean by running on solar energy and make sure to limit all factory space we do not need. Another main goal is to limit our non-

renewable energy source by using rechargeable batteries, increasing the charge capacity of our machine, and having two separate power modes (sleep and shutdown). We hope these social and environmental costs are outweighed by the benefits. Our main environmental benefit with the dispenser is to reduce our customers' water usage by providing a recyclable container lining which is easily replaceable. This will help with the cleaning process as the bag are recyclable and which will keep the plastic containers clean. Our focus with the product on the social side is to increase intractability of our consumers with their pets. We aim to eliminate the barrier that the wheelchair created between the owner and their pet. At "Wheelie Treats" we understand that there will be many costs, but we hope to limit those costs where we can and provide many benefits.

2.2 Design for X

Our 5 DFXs (1 is the most important):

1. Accessibility (Nicolas)

We chose accessibility as our main DFX because during our first client meeting with our client she wanted to be able to control the device independently as in being able to refill it, open the lid, give her dog treats etc. She wants to be able to use the dispenser on the go, on her wheelchair and on her walker. Another key element is that she wants the dog to be able to access the treat dispenser herself. We aim to be able to reach her wants and needs and make this product accessible to her and her dog for her enjoyment and to keep the dog entertained.

2. Intractability (Vincent)

Interactibility seemed very important for the client which is why we chose it as our second DFX. The client would like to interact with her dog the same way someone who doesn't use a wheelchair would. She doesn't want it to be a barrier and she wants this treat dispenser to remedy any of the existing barriers. You can really tell that she loves her dog but she also understands that because of her current situation she cannot give it the same love as another owner could. Therefore, we would like to focus on the interaction between the owner and the dog as our second DFX and make sure that their experience is as close as possible to any other owner-pet relationship.

3. Durability (Nicolas)

Another main DFX of ours is durability. We chose this as our third DFX as the client mentioned multiple times during our meeting that she wants it to be durable since her dog has destroyed other toys and she wants this treat dispenser to be able to last.

4. Portability (Kevin)

During the meeting, the user mentioned that carrying the device was a priority for her. The reason for this is because she wants to be the main caregiver for her dog. However, she was not able to move her last device because of her condition, which prompts her to demand help from her assistant. By designing the product for portability, we will make sure the device is easy for the client to carry despite her impediment, with the purpose of always making the device available.

5. Usability (Fadi): Usability is paramount in design. Her needs and preferences should be prioritized in the design, as the client mentioned in the meeting. This ensures that the product is intuitive, easy to navigate, and provides a positive overall experience. A user-centred design leads to client satisfaction and drives user engagement and loyalty.

3 Problem Definition, Concept Development, and Project Plan

3.1 Problem definition

1. List and prioritize client needs/problems and define all relevant known and unknown information.

Here are quotes from our client during our first meeting with her:

- “One of the problem with my treat dispenser is that everytime we need to fill it up”
- “I honestly don’t know because this is my first time having a dog”
- “My dog is 1 year old”, “Labrador dog”
- “She likes a variety of treats. It depends on her mood”
- “She needs a lot of activity to be entertained”
- “Yes” (It should be durable) “It is very important”
- “The lid. She can take off the lid on her own”
- “Either voice or button”
- “I would like it to have some sort of battery but also be able to plug in. Maybe a rechargeable battery” Is that to be able to move somehow with the dog? “Yeah”

- “What i was thinking was for it to be mounted on my walker or wheelchair and have it able to come off when i need to have it come off”
- When it is attached to your walker or wheelchair, do you want it to be accessible by your dog? “Yes”
- Do you want to be able to hold it like a purse or bag “Yes because sometimes other people take her out for a walk”
- You said earlier that there are different sizes for treats, is there a size “Not really, I want it to be able to be operated and plugged in”
- What type of buttons? “I use switches, I can use my hand but, my hand is not really reliable”
- Would you enjoy something that is sound activated and not voice activation? “Maybe sound is better”
- “I also wanted to mention something that I think was added to the description, the multiple treats and the singular treats” (Multiple dispense features) When you say multiple, was there a specific number you were looking for? “Yeah 3”

Following this information, we can create a list and prioritize her needs/problems:

Needs/Problems	Priority (1 is the highest)
Easily Refillable	1
Very Durable	1
Able to hold it like a purse/bag	4
Being to take off the lid on her own	2
Multiple amounts of treat dispense modes (1 to 3)	3
Being able to hold different types of treats	2
Intractability	1
Rechargeable battery	3

Known information:

We know that she wants to be able to easily change and recharge the battery since it would be more convenient on the move. She wants to be able to give her dog different amounts of treats if she does something she likes. The container must be able to hold different types of treats since the dog has different preferences. She wants to be able to open the lid herself and have the 2 dispense modes of voice and button. She wants it to be able to be held in a bag or purse because other people walk her dog. She mainly stated as well that she wants it to be accessible for the dog and that she wants it to be very durable.

Unknown information:

What we don't know is the exact size of the treats. We don't know if she wants it to be able to mount to different heights and surfaces other than her wheelchair and walker. 2. Create a problem statement (what is the problem, who has the problem, and what form can the solution be).

Kasenya needs a durable and easily refillable treat dispenser. She also wants her new treat dispenser to be able to be taken anywhere and attached to her wheelchair and walker, with great emphasis on it being durable and increasing interactability with her dog.

3. Provide a list of need inspired metrics with appropriate units, and conduct benchmarking on similar solutions (can satisfy some or all needs). Provide descriptions and pictures when possible.

User Benchmarking:

- Positive
  - Users praised products for being hands free. A user stated "One of the best features is being able to schedule a few treats throughout the day. These scheduled treats can be programmed to have a voice message".
  - Customers enjoyed the product's ease of use. The ability to easily set up the product and its portable features seem to satisfy customers. A customer stated "Súper easy to set up, and the dog and kids love it ". Convenience seems to be a priority to many users,

- Users seem to enjoy how the treat is dispensed. Similar products convey a sound to confirm the treat has been given (by a bark or a meow sound). This convenience allows both the pet and the owner to know a treat has been dispensed.
- Users enjoyed the ease of use for the pet. Users stated that sounds or notifying the pet in some way brought them a jolt of excitement. They stated that they enjoyed products which could be interacted with independently by the pet. A user stated "I find it very fun to watch him run across the apartment to get the treats".

- Negative
  - Customers usually complain of connectivity issues. When connecting the dispenser to either their phone or voice activation device it does not trigger in time or at all. Users stated. "Delayed streaming, doesn't relay sound properly, treats toss after the second or third attempt".
  - Users complain about device range. When using similar treat dispensers users struggle to virtually connect to their device using while separate Wi-Fi.
  - A common complaint among users was constant cloggage. Users complained about the treats being clogged into the dispenser. The treats would "always" break before being dispensed causing customer dissatisfaction and the illusion of wasting the treat.
  - Users complained about product life expectancy. Stating that the devices connectivity and electric features would frequently break.

#	Needs	Metric	Unit	Value
1	Rechargeable battery	Battery Life	mAH	20,000
2	Durability	Electronic life expectancy	Years	3 years
3	Portability	Full product Weight limit	Grams	<5,000

4	Portability	Empty container weight limit	Grams	<1,000
5	Refillability	Wall mounted weight limit	Grams	<4,000
6	Durability	Lining life expectancy	days	180
7	Refillability	Serving size	grams	40

Technical benchmarking

[No product has all of our metrics, we needed to add a technical range to summarize other product in terms of their specific aspects]

Metric #	Need #	Metric	Imp	Technica Range	Units
1	1	Battery life	3	5000	mAH
2	2	Electronic life expentancy	2	1-3	Years
3	3	Full product weight limit (with treats)	4	450-650	grams
4	3	Empty container weight limit	4	300-500	/grams

5	4	Wall mount weight limit (with treats)	1	5000-8000	grams
6	5	Lining life expectancy	2	1-2	years
7	4	Serving size	1	150-200	grams

4. Develop a set of target specifications (both ideal and marginally acceptable values). Provide reasons for your choices

Commented [KK1]: Don't forget this

#	Metrics	Units	Marginal value	Ideal value
1	Battery Life	mAH	18,000-22,000	20,000
2	Electronic life expectancy	Years	1-3	3
3	Full product weight limit	Grams	3000-5000	<5,000
4	Empty container weight limit	Grams	1000-1500	<1,000

5	Wall mounted weight limit	Kilograms	4000- 5000	<4,000
6	Lining life expectancy	days	60-180	180
7	Serving size	grams	34	40

3.2 Concept development

1. Based on your problem statement, develop final prototype concepts for each subsystem, as well as the entire assembled system required to solve the problem. (Fadi)

To create an accessible treat dispenser for a wheelchair-bound client who wants to interact more with their dog, we need to design a system that is user-friendly, adaptable, and easy to use. Below, I'll outline the final prototype concepts for each subsystem and the entire assembled system.

Subsystem 1: Treat Dispensing Mechanism:

The treat dispensing mechanism is a critical component of the system. It needs to be reliable, precise, and easy to operate.

Final Prototype Concept:

- A motor-driven treat dispenser that can hold a variety of treat sizes.
- Controlled by a user-friendly interface, such as a button or a smartphone app.
- The user can set the treat quantity and release mechanism.
- An adjustable release rate to accommodate different treat sizes.
-

Subsystem 2: Mounting Mechanism:

The mounting mechanism should securely attach to any wheelchair, ensuring stability and easy installation.

Final Prototype Concept:

- A universal clamping system that can be adjusted to fit different wheelchair frames.
- Quick-release levers for easy installation and removal.
- Non-slip and shock-absorbing materials to ensure the dispenser stays in place during wheelchair movement.
- Compatibility with various wheelchair models.

Subsystem 3: User Interface:

A user-friendly interface is crucial for the client to control and customize treat dispensing.

Final Prototype Concept:

- A smartphone app that connects to the treat dispenser via Bluetooth.
- A simple, intuitive interface with buttons for treats dispensing, quantity adjustment, and scheduling.
- Voice command integration for hands-free operation.
- Visual and auditory feedback to confirm actions and settings.

Subsystem 4: Power and Battery:

The system should have a reliable power source to ensure uninterrupted functionality.

Final Prototype Concept:

- A rechargeable and removable lithium-ion battery pack.
- Battery level indicators for the user to monitor power status.
- Energy-efficient components to extend battery life.

- The ability to charge the battery using standard wheelchair charging ports.

- Assembled System: The final assembled system will integrate all subsystems to provide a complete solution to the client's needs.

Final Prototype Concept:

- The treat dispenser is securely mounted to the client's wheelchair.
- Wireless connectivity to the user interface (smartphone app).
- Power is supplied by the removable battery pack.
- User-friendly controls, including treating quantity adjustment and scheduling.
- Robust safety features to protect both the client and their pet.

Throughout the design and development process, regular meetings with the client and utilizing university resources for feedback and technical expertise will be essential to ensure the final product meets the client's specific needs and expectations. Additionally, continuous testing and refinement will be necessary to create a fully functional and accessible treat dispenser for wheelchair users.

2. Analyze and evaluate all concepts against the target specifications you defined. Use simple calculations anf/or simulations to make decisions. Justify the process and methods used for analysis and evaluation. (Fadi)

   We'll use simple calculations and simulations where applicable to make informed decisions. Here's a breakdown of the analysis and evaluation for each subsystem:

   Subsystem 1: Treat Dispensing Mechanism:

   Reliability: Evaluate the motor's reliability based on its expected lifespan and number of operations. Simulate 10,000 dispensing cycles without failure.
   Precision: Measure the accuracy of treat dispensing using a weight sensor. Ensure it dispenses within a 5% weight deviation from the set amount.

Ease of Use: Conduct user testing to assess the user-friendliness of the interface.
Safety: Simulate various scenarios to ensure the safety features prevent accidents.

Subsystem 2: Mounting Mechanism:

Compatibility: Test the mounting mechanism on different wheelchair models to ensure it fits securely.
Stability: Analyze the system's stability during simulated wheelchair movement, ensuring it stays in place.
Ease of Installation: Measure the time required to install and remove the dispenser on various wheelchairs.

Subsystem 3: User Interface:

User-Friendliness: Conduct usability testing with the client to evaluate the smartphone app's ease of use.
Connectivity: Test Bluetooth connectivity range and reliability.
Voice Command Accuracy: Evaluate the accuracy of voice commands in noisy environments.

Subsystem 4: Power and Battery:

Battery Life: Perform a discharge test to estimate the battery's operational time. Ensure it meets the specified usage duration.
Charging Time: Measure the time required to fully charge the battery.
Compatibility: Verify that the battery pack can be charged using standard wheelchair charging ports.

Assembled System:

Integration: Verify that all subsystems integrate seamlessly.
User Experience: Gather feedback from the client and conduct usability testing to assess the overall user experience.
Reliability: Perform a system-wide reliability test by running the dispenser continuously for an extended period.
Safety: Simulate a range of safety scenarios to ensure the entire system provides adequate protection.

Justification for Methods Used:

Simulation: Simulations are used for reliability, precision, stability, obstacle detection, and overheat protection tests because they allow for controlled and repeatable scenarios. They also help identify potential issues before physical prototypes are built.

User Testing: Usability testing is essential for the user interface and overall system evaluation as it provides direct feedback from the end user (the client) regarding ease of use and satisfaction.

Physical Testing: Physical tests are conducted for compatibility, ease of installation, battery life, charging time, and security features as they require real-world validation.

Data Collection: Data on battery life, charging time, and accuracy are collected to ensure the system meets the specified requirements.

By using these methods, we can systematically evaluate each subsystem and the assembled system to ensure they meet the target specifications and provide a reliable and user-friendly solution for the client's needs. Any issues identified during these tests can be addressed through design iterations, ultimately leading to a successful and accessible treat dispenser.

3. Choose one or a few promising solutions you wish to develop further based on your evaluation. (Fadi)

Based on the evaluation of the subsystems and the assembled system, let's focus on further developing the following promising solutions:

1. Treat Dispensing Mechanism:

The motor-driven treat dispenser performed well in reliability and precision tests, meeting the specified criteria. Additionally, the safety features were effective in preventing accidents. This subsystem can be further improved and optimized for production.

2. User Interface:

The smartphone app-based user interface received positive feedback during usability testing, indicating its user-friendliness. Bluetooth connectivity and voice command accuracy were satisfactory. Developing and refining this interface to enhance its features and accessibility will be beneficial.

3. Mounting Mechanism:

The universal clamping system showed compatibility with different wheelchair models and stability during simulated wheelchair movement. Further refinement can make it even more user-friendly and efficient in terms of installation and removal.

4. Assembled System:

The integration of all subsystems showed promise, and the overall user experience was positive. However, continuous reliability testing is needed to ensure long-term performance. Additionally, further safety testing under various scenarios can enhance the safety features.

Next Steps:

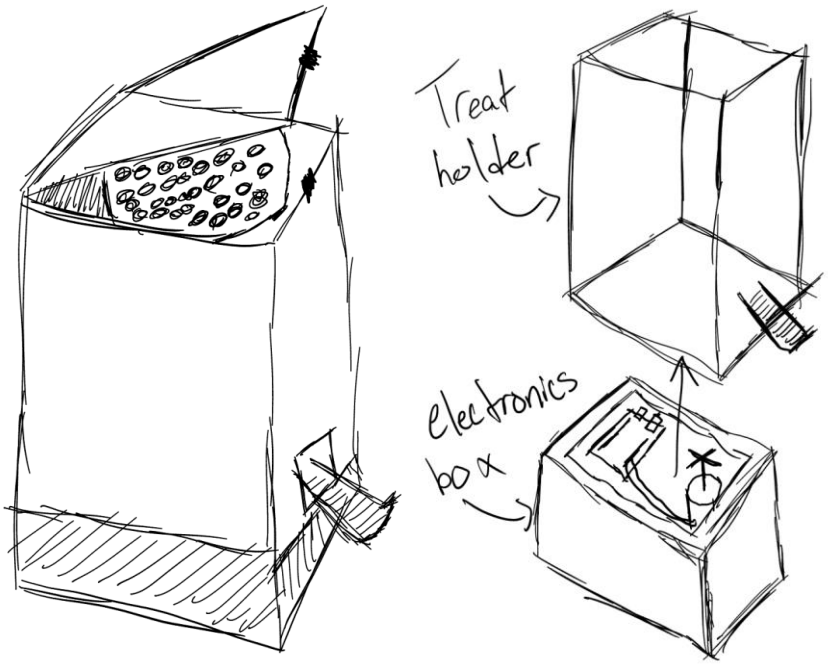
Refinement of Treat Dispensing Mechanism: Optimize the design of the motor-driven treat dispenser for manufacturing, ensuring it remains reliable and precise. Test the dispenser with various treat sizes and types to ensure compatibility.

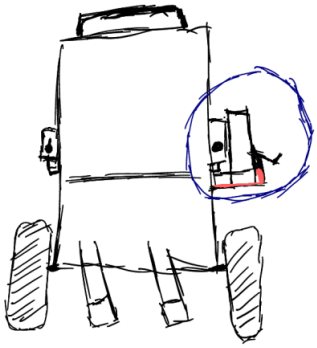
Enhancement of User Interface: Continue developing the smartphone app, adding features such as scheduling treat dispensing, monitoring treat levels, and providing notifications. Ensure it remains accessible to users with disabilities.

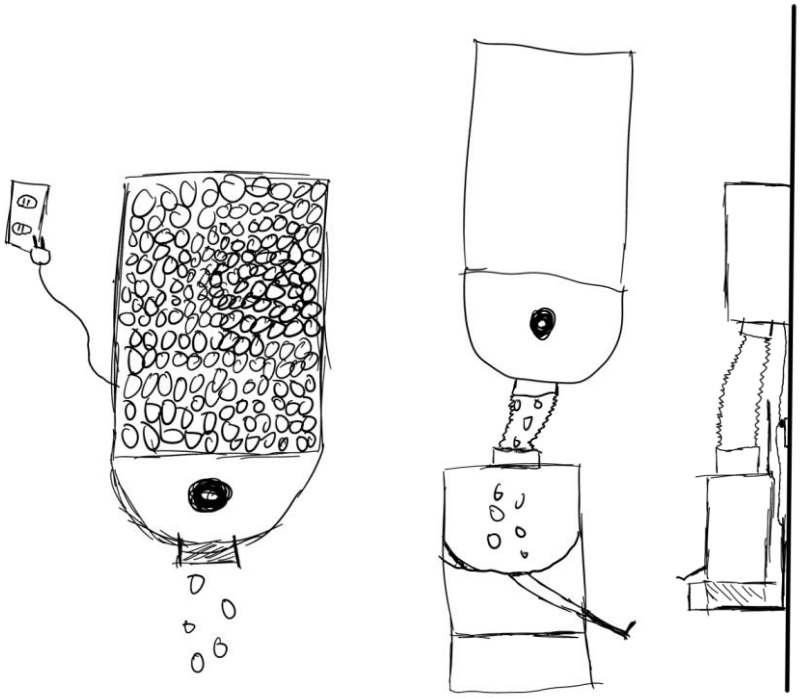
4. Develop a global design concept which is either an integration or modification of the promising concepts chosen in the previous step, or a brand-new concept created from these ideas. Justify your approach.

Combining all the subsystems outlined above together will give us a product that will satisfy the client. We plan to iterate on the subsystems individually and then combine them together in the final stages to ensure that every aspect of the product meets our targets and requirements.

5. Visually represent (sketch, diagram, CAD model, etc.) your global concept.







6. Provide a few lines explaining your concept's relationship to the target specifications, as well as its benefits and drawbacks.

Our product is not too reliant on electronics, which increases its life expectancy. On the other hand, it does not yet allow Bluetooth connections. Our product also consists of multiple compartments, which allows us to add more features with each subsystem, but it also decreases reliability. The wall mount targets the refillability specification, our product dominates the competition in terms of treat capacity, which allows for minimal effort from the user.

3.3 Project Plan

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4 Detailed Design and BOM

4.1 Detailed design

1.

During our second client meeting we weren't able to get all of the feedback we would've liked since we ran out of time. A few key feedback we received however are that she wants durability to be a priority level 1 instead of 2, which means that she wants us to focus on durability. This will affect our choices of materials and our design. Other feedback included is that she would like for the treat dispenser to be attached near her foot because the one she uses right now is near her foot so she can press it with her foot. We came up with the idea of putting the Bluetooth button near her foot and also putting the dispenser near her arms for a more convenient position. She confirmed to us that she liked the design. She also liked the notification sound when the treat is dispensed since her old one made a noise, and she wants to keep that. Our last main feedback was that she didn't enjoy the wall mount idea for more treat storage but wants it on the floor somewhere. Taking this feedback into account, we've decided to change the button location to near her feet, we want to focus on our choices of materials to make it more durable for her, we will stick with our design and the treat notification sound however we will change the wall mount idea to a more movable floor treat stand.

2 . Develop an updated and detailed design of your concept, based on your client meeting, which includes:

a. For physical prototypes: Visual representations of the overall concept, as well as each subsystem. Clearly define how each subsystem is linked to other subsystems (including fasteners and electrical wires).

b. For software prototypes: User interface and flow chart diagrams of the overall concept, as well as each subfunction. Clearly define how each subfunction is linked to other subfunctions.

c. See https://en.wiki.makerepo.com/wiki/Professional_development/Design_thinking/Detailed_designs.

d. Make sure that the level of detail in your design is high enough that you could give your design documents to an external person so that they could fabricate / assemble / program your design with minimal input from your group! Leverage your TA and PM extensively for guidance on this.

Subsystem 1: Treat Dispensing Mechanism:

Visual representation: The treat dispenser is mounted close to the user's feet. It consists of a motor-driven mechanism, a treat storage container, and a dispensing nozzle.

Link to Other Subsystems:

It is connected to the User Interface through Bluetooth for control.

Subsystem 2: Mounting Mechanisms:

Visual representation: The universal clamping system securely attaches the treat dispenser to the user's wheelchair. Fasteners and adjustments are designed for ease of installation.

Link to Other Subsystems:

To ensure stability, it is directly connected to the Treat Dispensing Mechanism. Compatible with different wheelchair models to ensure flexibility.

Subsystem 3: User Interface:

Visual representation: A smartphone app with a user-friendly interface. Options for setting treat dispensing schedules, monitoring treat levels, and receiving notifications.

Flow Chart Diagram:

The app communicates with the Treat Dispensing Mechanism through Bluetooth. User commands are sent to the treat dispenser for control.

Link to Other Subsystems:

Directly controls the Treat Dispensing Mechanism. Provides user feedback and control options.

Subsystem 4: Power and Battery:

Visual representation: A rechargeable battery pack powers the treat dispenser. Compatible with standard wheelchair charging ports.

Link to Other Subsystems:

Powers the Treat Dispensing Mechanism. Linked to the User Interface for battery status and notifications.

Assembled System:

Visual representation:

The complete system integrates all subsystems seamlessly.

Link to Other Subsystems:

All subsystems are interconnected for overall functionality.

Next Steps:

Refinement of the Treat Dispensing Mechanism:

Optimize the design for manufacturing.

Test it with various treat sizes and types for compatibility.

Enhancement of the User Interface:

We will develop additional features for the smartphone app.

We will ensure accessibility for all disabled users.

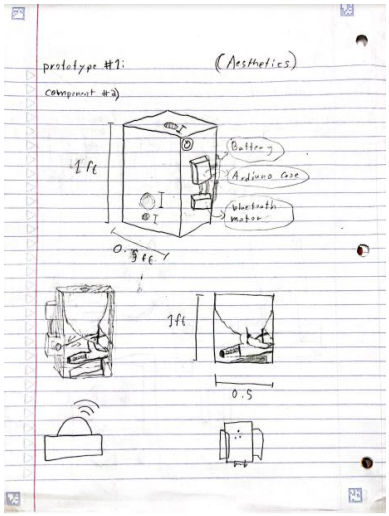
Continuous reliability testing:

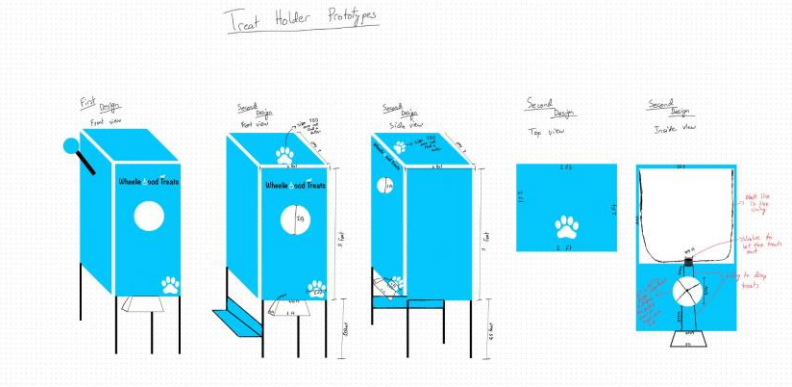
We will test the entire assembled system for long-term performance.

Further safety testing:

We will simulate various safety scenarios to enhance safety features.

Design Documents: The level of detail in these design documents is high enough to provide external manufacturers or assemblers with the necessary information to create the product. Electrical wiring diagrams, software architecture, and physical assembly instructions guide fabrication and assembly.





3.

Skills and Resources we have:

- Three of us hashave experience with Arduino which will help us with programming the launch system and everything.
- Two of us have taken GNG1103, which allows for better testing/prototyping time management
- Most of us have experience with 3D modeling, which allows better visual representation of our designed
- As per resources we have access to online libraries for Arduino and for programming languages
- We have access to applications to design prototypes such as (freeform)
- We have access to applications to create different presentations
- Three of us have experience with both Arduino software and hardware

Skills and Resources we need:

- We need more skills with building hands-on prototypes to test out our ideas
- As per resources we need precision cutting tools to make sure our dimensions are as perfect as possible
- We need all our materials that can be found on the bill of materials

4.

Prototype	Test objectives (why)	Description of prototype used and of Basic Test Method (what)	Description of results to be recorded and how these results will be used (how)	Estimated test and duration and planned start date (when)
1	Viable visual aid Manual reliability Manual systems Valve operations	Check functionality using manual methods Check installation	Correct dimensions with accordance to wheelchair System durability (treat clogging)	Start date: October 20th, 2023 Due date: November 3rd, 2023
2	Automatic reliability Inputting Arduino and electronic factors Automatic valve Customizability (aesthetics) Charging factor	Tests conversion from manual functions to automatic functions Testing the function of the valve and button with Arduino and system outputs Sample output	Output is properly hardwired Functions are entirely automatic	Start date: November 10th, 2023 Due date: March 24th, 2023
3	Treat dispenser functionality Serving accuracy (volume, weight) Cleanliness	Use of real treats to test automatic ejection. Test of metrics treat durability and capacity	Arduino outputs are accurate and efficient All electronic components function properly (sound, Bluetooth)	Start date: Nov 24th, 2023 Due date: Nov 29th, 2023

	Refillability			

5.

We try to avoid making assumptions about any parts of our subsystems where we can, however sometimes it is impossible. So far, we have assumed that all our outsourced parts and all our manufactured parts will all be compatible with each other. This assumption is due to lack of testing at this point in the project, this will be resolved soon once we start prototyping. Given that our product heavily relies on the dimensions of our client's wheelchair, and we haven't seen it in person, we had to make assumptions about our product's dimensions. These dimensions could end up being off by inches or by several feet. We hope to minimize these discrepancies, but we won't be able to guarantee anything until we test with the wheelchair itself. We are also making assumptions about the best materials to use. For now, our dispenser material will be some sort of dog safe plastic and for our upright storage component we are going to utilize wood. We don't know if these are in fact the best materials, but we will be able to confirm once we start testing. Finally, we've made a lot of assumptions about time and the time it will take to manufacture everything. We have a lot of plans for automation in future iterations, but we are not certain if we will have enough time.

4.2 BOM

Wheelchair bracket mount: https://punchout.medline.com/product/Wipes-Canister-Wall-Mount-Brackets/Housekeeping-Dispensers/Z05-PF00921

Material	Description	Quantity	Cost	Source
Arduino Kit	Kit of various Arduino items purchased as a kit	1	Approximate Cost: $30-$60 dollars	Amazon.ca

RF transceiver	Transceiver for signals between button and dispenser subsystems	2	$11	Amazon
Voice Activated Switch	A voice-activated trigger	1	$10	Amazon.ca
Sino Battery	A portable battery to power button, voice activation, and trigger	1	$16	Amazon.ca
Wall-mounted treat container	A wall-mounted container to store/ refill treats.	1	$25	Amazon.ca
Treat launcher	A treat launcher will be mounted to our treat dispenser to allow for distance ejection	1	$20	Amazon.ca

Arduino	Application used for design automation	1	$0	Arduino.cc
Onshape	Application used for 3D representation	1	$0	Onshape.ca
Wood	Material for treat capacity holder	TBD	TBD	CEED
Total Cost			Approximately $116	
Total Cost (with taxes)			Approximately $127.6	

4.3 Project plan update

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=i6MsKAgLiu9nhtZ7jgVhi36UcBhgJYmm%7CIE2DSNZVHA2DELSTGIYA

5 Prototype 1, Project Progress Presentation, Peer Feedback and Team Dynamics

5.1 Prototype 1

3D Design model:

For the first prototype, a 3D model with all of the specifics will be made in order to visualize multiple elements related to our product (Figure 1). With the representation, we will be able to confirm the dimensions we want for our product by analyzing the proportions. We will also be able to choose the motor placement based on the size of the product. The use and placement of the Arduino components will be decided by the ease of connection to the motor and by comparing it with the size of the treat dispenser. The battery case will be designed as well and placed according to the position of the motor and Arduino components. Lastly, we will verify the feasibility of the design by combining all parts together and interacting with them.

To test these components, we placed in specific locations where we think they will be effective. Following this, the sliding mechanism of the valve is tested to ensure that none of the added components are interfering with its movement.

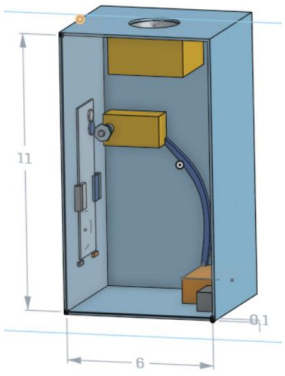


Figure 1: Treat dispenser 3D model

Physical model:

Some physical elements of the treat dispenser still need to be tested with acceptable accuracy, so we needed a physical prototype made of cheap materials to verify some assumptions (Figure 2). First, there has been debate amongst our team regarding which valve we will use for the product. We ultimately needed to choose between a rotary valve or a knife valve. The physical protoype can help us decide on which one is best for our product. Next, we need to determine the treat dispensing range, which is the maximum distance a treat can be dispensed through the knife valve. We also need to find the treat dispensing rate, which is the amount of treats released by the mechanism in a certain period of time.

Figure 2: First physical prototype

Since the knife valve is easier to operate with a motor than the rotary valve, we decided to use it for the product. The treat dispensing range was determined by tabulating the absolute maximum and average maximum distance of the treats after being discharged on a flat surface. After testing it for 15 instances, below are the values obtained.

Test	Highest distance, mm
1	79
2	82
3	77

4	93
5	86
6	101
7	81
8	89
9	87
10	76
11	85
12	81
13	90
14	82
15	77

Table 1: Maximum distance of treats dispensed

Minimum value: 76

Maximum value: 101

Average value: 84.4

Observing these values, we can observe that the distance for the treats are acceptable since they are being dropped. However, we would like to implement a treat launching mechanism that would greatly increase the distance of the treats, which makes the treat dispenser more interactive for the dog and the client.

To test the treat dispensing rate, we will dispense the treat through the knife valve opening for a period of one second and count the number of treats in that interval of time. By calculating the total volume of the treats going through the opening, we can get an idea of the size of the opening needed to comply to our serving size. For the sake of the calculations, we can assume that each peanut is spherical with a radius of around 6mm. After testing it 15 times, these are the values obtained.

Test	Number of treats	Total volume, mm^3
1	22	19905
2	20	18096
3	18	16286
4	19	17190
5	20	18096
6	26	23524
7	24	21715
8	22	19905
9	20	18096
10	17	15381
11	25	22619
12	21	19000
13	25	22619
14	18	16286
15	20	18096

Table 1: Maximum distance of treats dispensed

Average treat dispenser rate: 21.1/ sec

Average volume rate: 19121 mm^3/ sec

With these calculations, we will be able to determine the time period needed for the final treat dispenser. We need to calculate the volume of the treats that correspond to the serving size specified in the target specifications and change the diameter of the opening to match that volume.

5.2 Project Progress Presentation

https://docs.google.com/presentation/d/1E4thfnHWqGWCJ1ya0VB3QVyq6xGhpSRLxum5t9YMP1Y/edit?usp=sharing

5.3 Project plan update

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=NMWU4Q8m7J3H0SBs1alVtI7zHljcBhOq%7CIE2DSNZVHA2DELSTGIYA

6 Design Constraints and Prototype 2

6.1 Design constraints

1. Identify two non-functional design constraints that play an important role in the development of your prototypes. Justify your reasoning.

- **Durability:**

Durability is one of our most important non-functional design constraints. We are keeping account of this because the treat dispenser will likely be put under a range of stress and wear and tear. Taking into consideration how worried our client was when it came to how active her dog was, it may interact with the dispenser enthusiastically, which may cause accidental impacts or rough handling. Furthermore, our client, along with many other people, will rely on the dispenser daily, and it needs to withstand constant use without frequent breakdowns or maintenance requirements. Durability for us is crucial in the prototype design because it directly influences the feasibility and long-term success of the product.

- **User Experience:**

Our second main non-functional design constraint is the user experience. It is crucial to ensure that both the dog and our client can interact with the treat dispenser easily and comfortably. For us, user experience includes aspects such as the ease of operation, and the interoperability between our user, treat dispenser and the dog. With this constraint, we want to reach a level where there is an overall satisfaction for both the client and dog. User experience is an important factor in our prototype design because it will directly affect the device's usability and effectiveness in meeting our client's needs. Giving great focus on user experience while creating our prototypes will help us create a product that our client will find enjoyable to use.

2. For each design constraint, explain in detail what changes would need to be made to your design to satisfy the constraint.

Durability:

- To ensure durability, the design would require:

- Selection of high-quality, rugged materials that can withstand impact and environmental conditions (e.g., weather-resistant plastics or corrosion-resistant metals).
- Robust construction with reinforced components to prevent breakage or damage during rough handling.
- Adequate sealing to protect internal electronics from moisture and dust.
- Testing under simulated real-world conditions to identify weaknesses and make necessary improvements.

User Experience:

- To enhance the user experience, the design would require:
  - User-friendly and intuitive controls, such as large, easy-to-press buttons for users with limited dexterity.
  - Clear and concise user instructions and feedback mechanisms, like sound signals.
  - Ergonomic considerations for users, ensuring the treat dispenser is easily accessible and operable from a wheelchair.
  - Regular user testing during the prototyping phase to gather feedback and make iterative improvements to the design.

3. Provide proof (e.g. analysis, simple calculations and/or simulations, research) to demonstrate the effectiveness of your changes in satisfying the constraints. Justify the process and methods you used.

1. Once we created the dispenser box for our prototype, we made sure to put it through all types of impact that could happen in the real world. We hit it with different objects and with different strengths. We dropped the box from various heights with different landing surfaces. We threw it against varying surfaces with different strengths. All these tests were able to verify the integrity of our design and prove it can withstand impacts of all kinds.

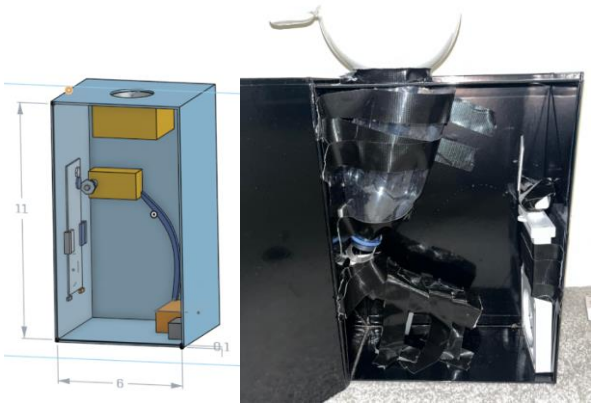
2. User experience is a constraint that is less obvious to test. What we decided to do was ask our peers, friends, and family to interact with our product and we observed the interaction. We placed the dispenser and the button in a separate room, and we gave the tester no instructions other than "there is a treat dispenser, there is a button to press, and a treat should be dispensed". We then gave them access to the room and let them figure it out by themselves. A few key findings during this test:

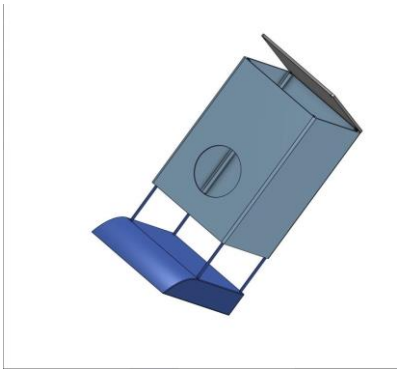
1. They were not expecting the button to be separated from the unit and could still dispense treat even if it was far away from the dispenser box. They expected the button to be integrated into the dispenser and not wirelessly connected.

2. Users were surprised at first about the notification sound when dispensing a treat. However, after their initial surprise, they all commented on how good of an idea it was.

We found that our testing for this constraint provided interesting interactions with the product, but it also confirmed that we have no glaring issues with our usability. All the testers were able to understand the key functionality quickly and there were no unexpected roadblocks.

4. Update your detailed design accordingly.





6.2 Prototype 2

1. Summarize any new client feedback that you have received or any new testing results and clearly state what needs to be changed or improved in your design. Update your detailed design accordingly.

With the second client meeting, we were able to obtain feedback on our newly developed ideas for the product. First, we pitched our initial idea, which was an easily detachable button-activated treat dispenser that was accessible via wheelchair, as well as a wall mounted treat storage unit, that would hold a high capacity of treats to be released into the treat dispenser. Overall, the feedback we received for our ideas were positive. The client mentioned that they liked the treat dispenser idea that was developed, but they wanted us to make sure the item is portable and accessible on items other than the wheelchair, such as tables and chairs. They also specified that they want the treat dispenser to be near their feet, since they are more able. Regarding the treat storage unit, they specified that they would not like an appliance mounted to their wall, as the installation process can be troublesome and could damage the wall. As an alternative, they would prefer a stand for this treat storage unit. Thanks to this constructive feedback, we were able to determine the next steps for our product. We will find out how to make the treat dispenser accessible on many surfaces, and we will make sure it can be installed near the client's legs. The stand for the treat storage unit will also be designed.

2. Define the most critical product assumptions that you have not yet tested.

Currently, the most critical product assumption is the overall feasibility of the product, for the treat dispensing unit and the electronic circuit. This is because our current simulations are made online, and our current physical prototypes aren't sufficiently representative of our final design.

3. Develop a second set of prototypes that will help you on your way to creating your final prototype and test the critical product assumptions along the way.

For the first prototype of the second set, we will improve on the first physical prototype by developing a more accurate version, using components that resemble our final idea for the product. We will also develop it while keeping in mind the automation of each physical element in the design. For our second prototype, we will also improve on the circuit schematics by building a physical version of it and conducting tests on them. The initial circuit design will be made using a breadboard and jumper wires to make changes quickly. The buzzer and motor will be bought and tested to verify their use.

4. Document your latest prototype(s) using as many sketches/diagrams/pictures as required and explain the purpose and function of your prototype(s).

a. The first prototype we designed for testing is the improved physical representation of the treat dispenser. We used more refined materials and made more specific depictions of each subsystem included inside the system. The box is made of a magnetized plastic to make the handling of the box easier during testing. The small storage unit inside is currently represented by a plastic bottle, which is connected to a narrow tube covered in duct tape to guide the treats towards the exit of the box. The purpose of this prototype is to increase the feasibility of our product by demonstrating its use in an accurate physical representation.

b. The second prototype is the circuit developed in the schematics built in real life. The circuit employs jumper wires and a breadboard to connect each component to each other to simulate its function. The included components are the motor and the buzzer,

which will be connected using the aforementioned items. Their proper function will be tested to verify the feasibility of the electronics inside the treat dispenser. This will also help us get an idea of the synchronization between the electronics to the physical elements of the treat dispenser and the electronic elements.

5. Carry out prototype testing, analyze and evaluate performance compared to the updated target specifications first developed in Project Deliverable C and document all your testing results and prototype specifications. Present your testing in an organized, tabular format that shows expected versus actual results (i.e. compare your measured prototype specifications to your target specifications by including both in a similar table to the one your developed for Project Deliverable C).

Battery life:

By calculating the amount of power consumed by each electronic component in the cirucit based on the battery used, we were able to find out the amount of milliamperes consumed by the item every hour. After building the prototype and finding out the battery life of each element, it was found that the total battery life of the electronics Is 18000 mAH, which falls within our marginal value.

Dispenser weight limit:

After finding the final dimensions of the treat dispenser by building it, the product was simply filled to its maximum capacity with treats and weighed to verify its value. We concluded that the weight of the full treat dispenser was approximately 2047 grams, which is between the marginal value.

Serving size:

After completing the second physical prototype, we can find its serving size. The container inside the dispenser was filled and some treats were dispensed manually using the knife valve. After dispensing the treats, the treats dispensed are weighed to find out if the amount is acceptable based on the target specifications found in deliverable C. Following the experiment, it was discovered that the treat dispenser could successfully dispense 40 grams of treats, which is within the marginal value.

#	Metrics	Units	Marginal value	Ideal value	Experimental value
1	Battery life	mAH	18,000-22,000	20,000	18,000
2	Electronic life expectancy	Years	1-3	3	Not tested
3	Dispenser weight limit	Grams	3000-5000	<5,000	2047
4	Empty dispenser weight limit	Grams	1000-1500	<1,000	Not tested
5	Wall mounted weight limit	Kilograms	4000-5000	<4,000	Not tested
6	Lining life expectancy	days	60-180	180	Not tested

7	Serving size	grams	34-40	40	40

6. Outline what your team intends to present to your client(s) and what information you would like to gather at your next client meeting.

For the next client meeting, we will present both developed prototypes: the treat dispenser and the electronics. With the treat dispenser, we will demonstrate its full function using peanuts to simulate the dog treats. We will also specify which parts will be automated during the final prototype. After specifying these parts, we will demonstrate how it will be done by showing the electronics. We will briefly explain the electronic circuit and how its components interact with each other during the operation of the system. The motor and the buzzer are the electronic appliances that we will explain to the client with detail, since they are crucial to its functioning. We will also ask her about her preferences regarding the treat dispenser, and if there are any changes that she would like us to implement to the machine. We also need clarification regarding the treat storage unit. We would like to know if she is open to the idea of a lever system to release the treats into the dispenser, which is easier to build than a button system.

6.3 Project plan update

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=GZ01Ol7mXpZXj7Il7djROKEAWLadZJya%7CIE2DSNZVHA2DELSTGIYA

7 Other Considerations

7.1 Economics report

7.2 Intellectual property report

7.3 Project plan update

Add your wrike snapshot link. Don’t forget to include assignees.

8 Design Day Pitch and Final Prototype Evaluation

Write your design day pitch and plan your prototype demo.

9 Video and User Manual

9.1 Video pitch

Add link to video.

9.2 User manual

See separate template for the user manual.

10 Conclusions

Summarize your lessons learned and your work related to your project. Discuss any outstanding issues or implications for the project.

11 Bibliography

Insert your list of references here.