GNG-2501

Product and User's Manuel

Team FC2-1

Douxphin Inc.

Submitted by:

Arnaud Abomo – 300391035

Emmanuel Kouakou – 300438209

Evelyn Harding – 300279784

Lilia Benjelloun – 300287865

Tania Pillay – 300342827

Zacharie Lachapelle - 300304018

April 4th 2025

University of Ottawa

Table of Contents :

1 Introduction

This User and Product Manual (UPM) is designed to provide essential information to administrators and users wishing to understand and operate our interactive sensory device. This product was developed to offer a soothing and immersive experience, integrating tactile, sound, and vibration technologies to simulate the presence and reactions of an animal. It is particularly suitable for people seeking gentle sensory stimulation, particularly in a therapeutic or recreational setting.

The manual contains an overview of the product, instructions on activating and using the various features (vibrations, sounds, movements), as well as recommendations for the maintenance and durability of the device. In the event of technical issues or assistance, this document serves as a first reference, offering detailed solutions and contact details for additional support.

This project is the result of a rigorous design thinking approach, incorporating user feedback throughout development. We require users to respect associated copyrights. This document belongs to our design team and must be used exclusively within the framework of the Animal Sensory project.

2 Overview

The goal for this project was to design a soft, durable, pet-shaped sensory stimulation device with rechargeable battery and easy activation, to soothe anxious, stressed and special-needs individuals. This is important because it can provide comfort and emotional support to the users. The pet shape mimics a companion, which can trigger positive emotional responses. This is especially helpful for individuals with anxiety, autism or dementia, who may benefit from the

calming effect of simulated pet companionship, mostly when they cannot have an actual pet to help with this. The soft texture and gentle vibrations or movements can provide soothing sensory simulation, helping reduce stress and agitation. The easy activation ensures that individuals with limited motor skills or cognitive challenges can use it without frustration. It's important for the product to be durable to withstand wear and tear seeing as individuals with special needs or anxiety may use the device frequently. This product can also provide predictable and calming sensory input for individuals with sensory processing disorders or on the autism spectrum, helping them self-regulate during overwhelming moments. The gentle vibrations, or rhythmic sounds can have a grounding effect, reducing sensory overload. This product could offer a non-invasive, drug-free way to mange stress and anxiety. In summary, this product can significantly improve quality of life, promoting calmness and emotional stability in individuals facing mental health challenges, neurodivergence, or high-stress situations.

Products stem from user needs. The following are the needs that were expressed to us to help us figure out what they want from our product and what functions or features are essential to meet their expectations:

- The activation buttons are large enough to press with the whole hand.
- The exterior of the product is made of soft fabric.
- The product is made of easy-care material.
- The product emits soothing sounds associated with the animal it represents.
- The product incorporates shades of blue and/or pink.
- The product has a long charge life.
- The volume of sounds emitted by the product is adjustable.
- The product emits soothing warmth.
- The product features a smiling face.
- The product is affordable.
- The product is light, stable and portable.

This product adheres to as many of those needs as possible.

Most sensory animal products of the market only come in cat form and are very expensive. The products out there that are in other forms of animals aren't exactly sensory animals seeing as all they do is talk, they don't include any types of movement that can help with sensory stimulation.

Our product is a cheaper alternative in dolphin form that includes movement for sensory stimulation in addition to audio.

Figure 1: The final prototype

This product includes a system of calming vibrations, tail movement, soothing music, reassuring aesthetics, and a plush with a soft durable texture.

The exterior of the product consists of a soft blue polyester material sewn into dolphin form with a zipper on its stomach for easy access for maintenance needs. The interior of the product includes a skeleton for the dolphin and a box made of MDF that holds the electronic components. The electronics components inside the component box include an Arduino UNO, a DF-Player mini audio player module, a micro-SD card, a battery, a boost converter, and a PCB board and all it's connections. The two vibration motors, the mini speaker, the charging module, the music switch, the servo motor, and the ergonomic buttons are attached to the outside of the component box and the skeleton as shown in figure 2. There are three ergonomic buttons, each with their own function. One activates the vibration motors which emit soothing vibrations, one activates the servo motor that wags the dolphin's tail, and the last one plays the calming music.

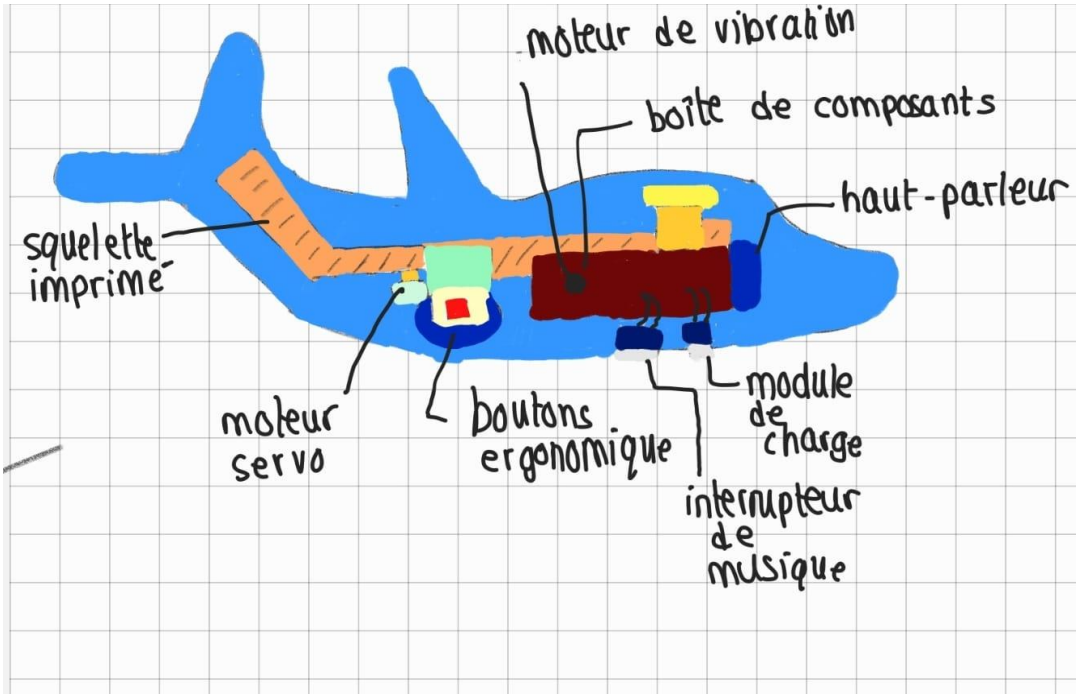

Figure 2: Functional diagram

2.1 Cautions and Warnings

If something happens to the exterior plush material, it is possible to clean it. However, it is very important to take out all the components inside the plush which includes the component box and all the electronic components, the skeleton, and the stuffing.

If you see a red light coming from the charging module, that means it needs to be charged, as the battery power is at less than 20% power.

3 To Begin

3.1 Configuration Conceptions

The final product is an integration of 3 different buttons that read the user's input, and feed the information to an Arduino microcontroller so that it can link the button data to the module connected to the button pressed. The three modules that can be activated by the buttons are a

vibration motor, a servo motor and an MP3 module. All this circuitry is powered by a 3.7V Lipo battery connected to a charging module to charge the battery and a boost converter to supply the Arduino with 5V.

The vibration motors vibrate quite strongly individually, but under about 4 cm of plush padding, the sensation they give is very calming and reassuring. They activate when their button is pressed, and remain activated to produce soothing vibrations until the button is pressed again to deactivate it. We recommend not to leave the motors activated for more than 30 seconds at a time.

The servo motor is responsible for shaking the plushie's tail once when the button is weighed. To do this, the motor is connected to both parts of the plushie's skeleton to ensure that only the tail moves when the motor is activated. The motor starts in its initial straight position, and moves once to the right, then to the left, then back to its initial position, all in about 2 seconds.

The MP3 module is connected to a small speaker to play dolphin sounds and relaxing music. It activates when the button is pressed, and deactivates when it is pressed again. The module is also connected to an external switch to toggle the option to activate the music. So if the switch is active, music cannot play when the button is pressed. If the switch is not active, nothing different happens and the music plays when the button is pressed. This option to toggle music activation is to ensure that the plushie won't make noise when the user is in an anxious situation where silence is desired, such as in a meeting.

3.2 Considerations for User Access

Anyone can use this product, whether they have accessibility problems or not. The large surface area of the ergonomic buttons and the high durability of the product ensure that it can be

used by a user with mobility problems who would not be able to make precise movements to activate normal buttons, or who would have difficulty keeping the product in their hands without dropping it.

3.3 Accessing/Installing the System

When the product is handed over to the user, it will already be fully installed and loaded, so no additional work is required to assemble it before use. The following steps will show the necessary process to follow to install the product if each detachable part is removed, which would be useful to follow in case intensive maintenance is required.

Figure 3: Step 1

Step 1: Open the zipper and remove around 60% of all the stuffing in the plush to leave space for the component box and skeleton.

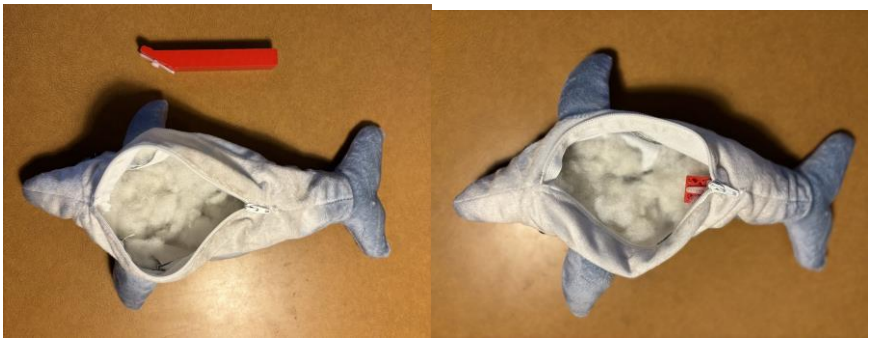

Figure 4: Step 2

Step 2: Insert part 1 of the skeleton (the red one) into the tail, ensuring that the part that connects to the servo motor is pointed towards you.

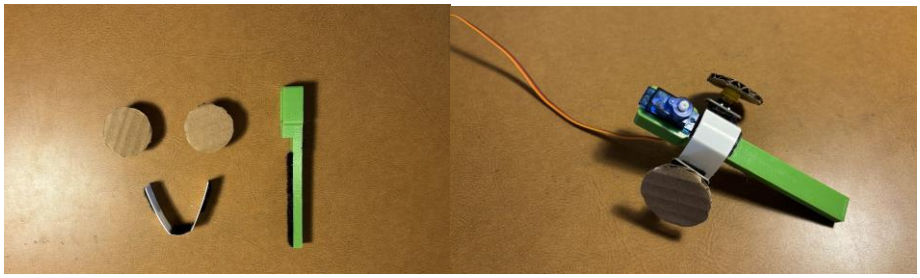

Figure 5: Step 3

Step 3: Take the rear button holder and connect the two buttons to the velcro at the end, then connect the holder to part 2 of the skeleton (the green one), also insert the motor into the hole in the skeleton so that the part that moves points in the same direction as the surface of the buttons.

Figure 6: Step 4

Step 4: Insert part 2 of the skeleton with the button holder into the plush, connecting the servo motor to part 1.

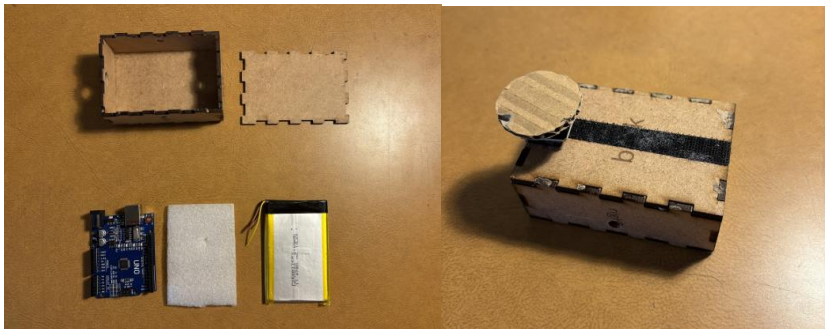

Figure 7: Step 5

Step 5: Open the component box and insert the electrical parts in the box in the following order: battery, foam, Arduino, foam, PCB, and cover. Then connect the last button to the end of the box with Velcro.

Figure 8: Step 6

Step 6: Insert the component box into the plush and connect it to part 2 of the skeleton with their velcro connections, ensuring that the surface of the new button faces the skeleton.

Figure 9: Step 7

Step 7: Replace as much padding as necessary to reinforce the box and ensure that no corners or solid surfaces are felt under the plush skin.

Figure 10: Step 8

Step 8: Close the zipper, and enjoy your new Douxphin.

3.4 Navigation and Organisation of the System

The following subsections describe all the physical and electrical connections required to operate the product.

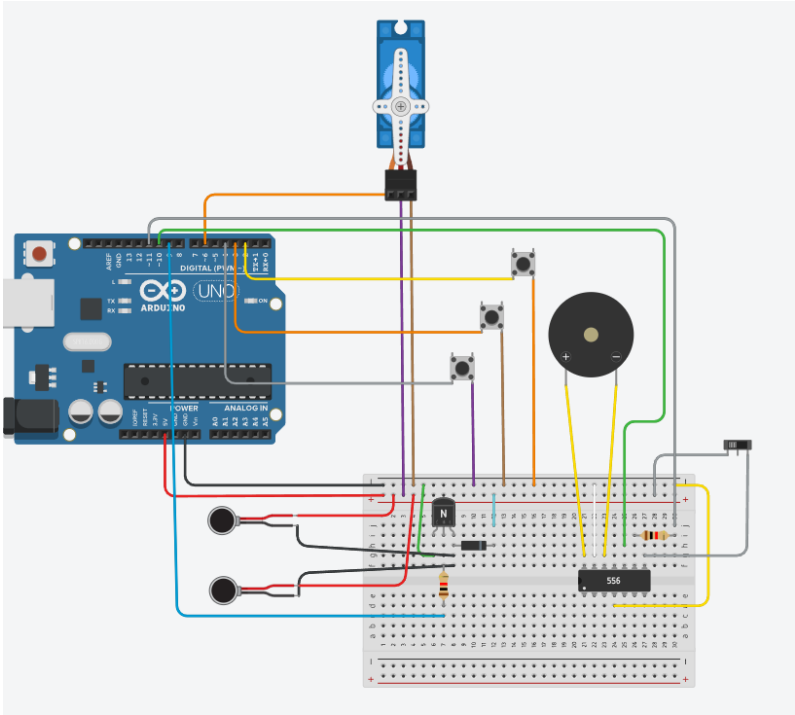

Figure 11: Complete Electrical Circuit on TinkerCad

3.4.1 Vibration Motors

For this section, there are two vibration motors that need to be connected, but this description will consider the two motors as a single motor, so you simply need to do exactly the same as the description does with one motor with the second.

An NPN transistor is used to control the current of the vibration motors. The base of the transistor is connected to a 1 kOhm resistor, which is then connected to terminal 9 of the Arduino. The collector of the transistor is connected to the common ground of the circuit, and the emitter of the transistor is connected to a diode. The anode of the diode is on the emitter, while the cathode is

on the circuit's 5 V source. The motor itself has its negative terminal connected to the transistor emitter, and its positive terminal to the circuit's 5 V source.

The button that controls vibration has its ground terminal (G) connected to the circuit's common ground, and its signal terminal (S) to Arduino terminal 3.

3.4.2 Servo Motor

The servo motor's signal pin (S) is connected to pin 6 of the Arduino, the ground pin (G) is connected to the circuit's common ground, and the motor's voltage pin (V) is connected to the circuit's 5 V source.

3.4.3 MP3 Module

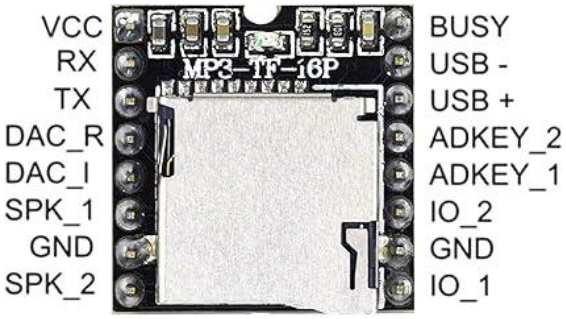

Figure 12: Connection Diagram for MP3 Module

The module's voltage terminal (VCC) is connected to a switch to give the user the option of toggling the module on or off to keep it silent. The TX terminal is connected directly to terminal 10 of the Arduino, while the RX terminal is connected to a 1 kOhm resistor to go to terminal 11 of the Arduino. Terminals SPK_1 and SPK_2 are where the two speaker pins connect (the order of connection is not important). The GND and ADKEY_1 terminals are connected to the circuit's common ground.

3.4.4 Battery

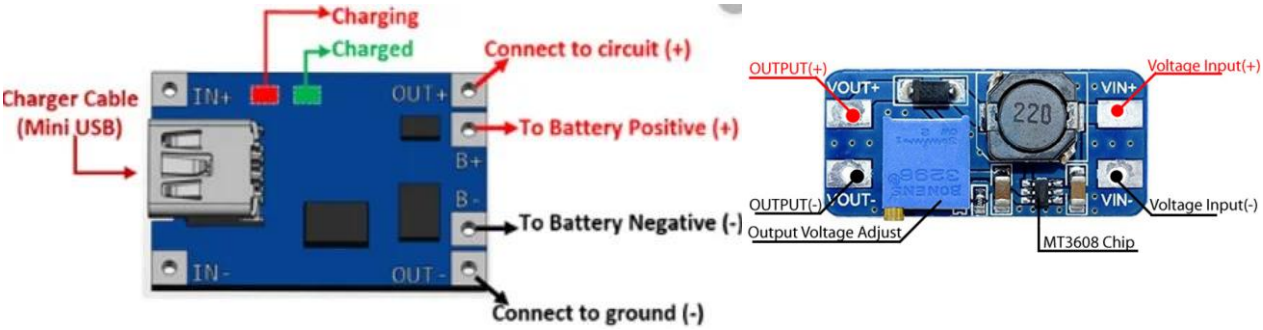

Figure 13: Connection Diagram for Charging Module and Boost Converter

The red wire (VCC) of the battery is connected to terminal B+ of the charging module (picture left) and the black wire (GND) is connected to terminal B- of the module. The OUT+ terminal of the charging module connects to the VIN+ terminal of the boost converter (image right), and the OUT- terminal connects to the VIN- terminal. The VOUT+ terminal connects to the Arduino's 5 V terminal, and the VOUT- terminal connects to the circuit's common ground. A micro-USB cable can be plugged into the charge terminal of the charge module to charge the battery.

3.5 Dismantling the System

The physical product doesn't need to be disassembled when you're finished using it - just store it in a clean, dry place, and charge it if necessary. If you want to stop using the product for an extended period, such as for more than a month, you should simply disconnect the battery from the circuit and ensure that it remains at around 75% of its charge. The following instructions will show you how to disconnect the battery safely.

Figure 14: Step 1

Step 1: Start by inverting the product and opening the zipper to give you an access point to the component box.

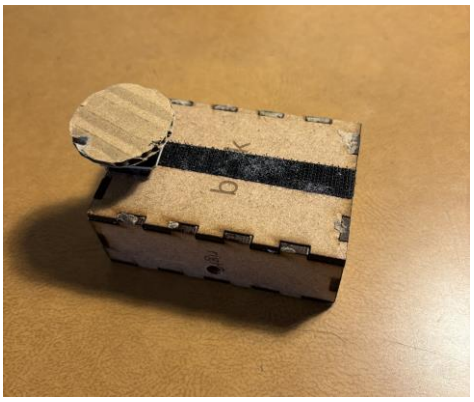

Figure 15: Step 2

Step 2: Remove the component box from its velcro connection to the skeleton.

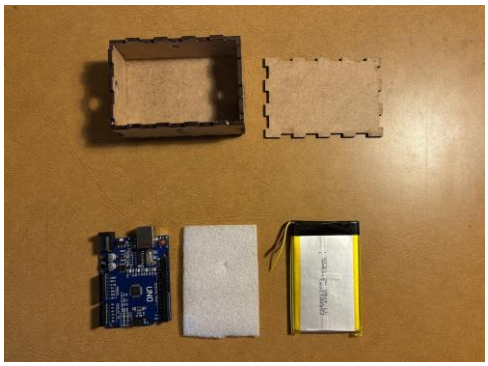

Figure 16: Step 3

Step 3: Open the lid of the component box and take out the Arduino, battery and circuit for better access.

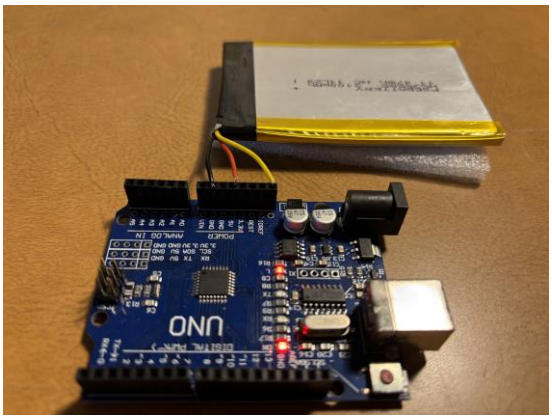

Figure 17: Step 4

Step 4: Disconnect the three cables connecting the battery to the Arduino.

Figure 18: Step 5

Step 5: Keep the battery in a dark, dry place between 0-25 degrees Celsius until you want to use it again. Charge it for about 15 minutes every week to retain as much of its long life as possible.

4 Using the System

This section describes in detail each function and feature of the system, providing a clear explanation of the user interactions required as well as the results produced. For each feature, we will look at the necessary input elements (such as pushing a lever, pressing a button, or interacting with a menu) and expected outputs. The sequentially numbered subsections (4.1, 4.2, 4.x) correspond to the various system functionalities, following the logical order of actions or menu items. If necessary, images and screenshots are included to illustrate the examples and help users understand.

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the Douxphin.

4.1 Overview of Features

This interactive plush is designed to deliver an immersive and playful experience by combining three core functions: vibration, tail movement, and sound production. These sensory elements are

carefully integrated to suit a range of uses and user needs. Each function is activated by an intuitive, ergonomically placed button, allowing for simple and seamless interaction.

The plush offers realistic vibration to mimic natural sensations such as purring, enhancing the tactile connection between the user and the toy. Its tail movement adds a lifelike, animated component that brings the plush to life, while sound production complements the experience with familiar animal sounds like purring or barking. These three features can also be activated simultaneously, creating a rich, multi-sensory environment.

Additional features include the ability to upload custom sounds via a micro-SD card, offering personalization and flexibility. Designed with soft, non-toxic materials, the plush prioritizes safety and comfort for users of all ages. Its rechargeable battery supports portability and extended use, making it an ideal companion for soothing, play, and imaginative engagement—especially for children and individuals with physical or sensory sensitivities.

4.2 Main features

The vibration function is intended to provide a realistic tactile response, simulating the comforting sensation of a purring animal or gentle movement. Activated by pressing the button on the right side of the plush, this function delivers a soft, rhythmic vibration that fosters a sense of companionship and calm. It is recommended not to leave the motor running for prolonged periods to preserve both battery life and component integrity.

The tail movement function is triggered by pressing the button located on the back of the plush. Once activated, the tail begins to sway in a natural, rhythmic motion that continues until the

button is pressed again to stop it. This animated movement is especially effective for engaging users, calming children, or mimicking the playful behavior of real animals, enhancing emotional and sensory engagement.

The sound production function is enabled through the button on the left side of the plush. When pressed, it plays animal sounds, such as purring, barking, or meowing, depending on the audio files stored on the internal micro-SD card. Dolphin sounds with music is preloaded by default. Sounds continue until the button is pressed again, and while the default volume is preset, it can be manually adjusted by modifying the device's code. This function brings an auditory dimension to the plush, enriching the immersive experience.

4.3 Warnings and Exceptions

- Do not leave the engine on for a long time to avoid overheating.
- Make sure the micro-SD card is inserted and formatted correctly.
- It is possible to activate all the functions simultaneously, but this results in a faster discharge of the battery.
- For a better experience, focus on clear and good quality audio files.
- Leave the battery fully charged for a better battery life.

5 Troubleshooting & support

To guarantee continuity of operation and maximize the benefits offered to the sensory animal, it is important to refer to any faults that may stop the plushie's system from working. This section is devoted to troubleshooting and support procedures for our plush. We'll discuss potential errors, preventive solutions, and provide appropriate instructions for solving common problems. Whether you're an ordinary user or a technician, this resource is designed to help you solve problems efficiently.

5.1 Potential operating faults

No	Common problems	Description	Corrective action
1	No reaction	Plush doesn't light up or respond	Load and test after at least 30 min.
2	Battery discharges quickly	The battery loses its charge quickly, even after a full recharge	Check the battery for damage or wear. Replace if necessary. Avoid leaving lint on when not in use.
3	Battery won't charge	Battery won't charge when plugged in	Check that the charging cable is working properly and that the charging port is not damaged. Try

			another compatible charger if possible
4	The plush no longer emits sound	No sound is emitted when the plush is activated or used	Check that the speakers are not obstructed or damaged. Restart the system to reset the audio settings.
5	The plush no longer vibrates	The vibration function no longer works, even when the plush is activated	Check that the battery is sufficiently charged to power the vibrations. Inspect the internal motor for visible damage or mechanical obstruction.
6	The plush has become wet	The plush has been exposed to water, which may affect its internal electronic components	Switch off the plush immediately and remove the battery if possible. Allow to dry completely in a dry place for at least 24 hours before trying to use it again. If it still doesn't work, contact technical support.
7	The plush is dirty	The surface of the plush is stained or dusty after prolonged use	Remove the electronic part of the plush and

			clean it with soap and water.
8	Blocked buttons or controls	Physical buttons or controls do not respond	Gently try to open it and check for obstructions, contact technical service if necessary

5.2 Special Considerations

Use: handle the plush with care and avoid exposure to water or extreme temperatures. Use only compatible chargers and never force buttons or ports. In the event of persistent problems, contact technical support before attempting any complex repairs.

Warning: Do not attempt to disassemble or modify internal components without consulting a qualified technician.

5.3 Maintenance

To ensure the longevity and smooth operation of the interactive plush, regular maintenance is essential. Here are some recommendations:

Maintenance task	Frequency	Instructions
Surface cleaning	Regular	Use a soft, slightly damp cloth. Avoid aggressive chemicals. For stubborn stains, remove electronic components (if possible) and clean by hand with water and mild soap. Dry thoroughly before reinserting components.
Checking the battery	Regular	Check the condition of the batteries or rechargeable battery, If the lint is not to be used for an extended period, remove the batteries.
Inspect connections and cables	Regular	Inspect connections, cables and charging ports for signs of damage or wear. Ensure that cables are correctly connected.
Storage	After use	Store the plush in a clean, dry place, away from direct sunlight and extreme temperatures. Avoid damp or dusty areas.
Functional tests (sound, vibration, movement)	Periodic	Perform regular tests to check that all functions are operating correctly. In the

		event of anomalies, consult the "Troubleshooting" section of the manual or contact technical support.

5.4 Assistance

For any questions, problems or technical assistance concerning the plush, please contact the following resources:

Main Technical Support :

- Manager : Arnaud Abomo
- E-mail : aabom040@uottawa.ca
- Availability: Monday to Friday, 9 :00 am to 5:00 pm (EST)

Problem Reporting Procedure :

1. Information Collection: Before contacting support, please gather the following information:
    - Detailed description of the problem encountered (include steps to reproduce the problem, if possible).
    - Plush model number (if applicable).
    - Purchase date and proof of purchase.
2. Report submission: Send an e-mail to the technical support address with the information collected. Include screenshots or photos, if they help illustrate the problem.
3. Follow-up: Technical Support will acknowledge your request within 48 working hours and provide you with a tracking number. Resolution times may vary depending on the complexity of the problem.

Security Incident Management:

In the event of an incident, please follow these steps:

1. Immediate Disconnection: Stop using the plush immediately.
2. Report Urgent: Contact technical support immediately by telephone at +1(343)9994161 or by e-mail, clearly indicating that this is a security incident.
3. Do not tamper: Keep the plush in its current state to facilitate investigation.
4. Cooperate: Cooperate fully with the technical support team and provide all information requested for the investigation.

Important note:

Technical support does not cover physical damage caused by misuse, neglect, accident or unauthorized modification of the product.

6 Product Documentation

6.1 Product Assembly

6.1.1 BOM (Bill of Materials)

Item Name	Link / Description	Price
MP3 Module	CANADUINO®	3.50$

SD Card	32GB Card Micro SD	7.02$
Velcro Strips	Hook and Loop Fasteners	4.36$
Mini Speaker	Round Micro Speaker	8.99$
Coin Vibration Motor	Vibration Motor	3.06$
Zipper	10inch Sewing Zipper	3.73$
Servo Motor	SG90 Micro Servo	2.60$
PCB	Double Sided PCB	1.50$
LiPo Battery	3.7v battery	10.00$
Charging Module	TP4056 Battery Charger	2.17$
Boost Converter	MT3608 Converter Boost	5.76$
Buttons	Tactile Tact Push Button	8.99$
Switch	On/Off Power Switch	1.00$
MDF	To make component box	Free in Makerspace
Transistor	TRANSISTOR NPN 40V	0.50$
Dolphin Plush	Dolphin Plush	16.49$
Arduino Kit	Basic Training Kit	20.00$
Arduino IDE	To make Arduino code	Free Online
Tinkercad	To design electric circuit	Free Online
SolidWorks	To design skeleton	Free Online
Ultimaker Cura	To print skeleton	Free Online

KiCad	To design PCB plan	Free Online
Written Code	To guide Arduino	Free Online
SoftwareSerial.h Library	For MP3 code	Free Online
Servo.h Library	For servo motor code	Free Online
DFRobotDFPlayerMini.h Library	For MP3 code control	Free Online
Soldering Kit	To make the PCB circuit	Free in Makerspace
Sewing Kit	To sew plush together	Free in Makerspace
Soldering Wire	To connect PCB	Free in Makerspace
Soldering Flux	To help connect PCB	Free in Makerspace
Wire Cutters	To make proper wires	Free in Makerspace
Plastic Strips	For button support	Free in Makerspace
Super Glue	For bigger button surfaces	Free in Makerspace
Cardboard	For bigger button surfaces	Free in Makerspace
3D Printing Resin	To print skeleton	Free in Makerspace
Multimeter	To test circuit connections	Free in Makerspace
Total	**99.67 $**	

6.1.2 Equipement List

- MP3 Module

- SD card
- Velcro strips
- Mini speakers
- Vibration motors
- Zipper
- Servo motor
- Double sided PCB
- LiPo rechargeable battery
- TP4056 charging module
- MT3608 boost converter
- Ergonomic buttons
- On/off switch
- MDF
- Cardboard
- 3D print resin
- NPN transistor
- Arduino
- Male to male wires
- Male to female wires
- Diode
- 1 kOhm resistances
- Dolphin plush
- Soldering kit
- Sewing kit

6.1.3 Instructions

Building the actual physical product from scratch has been talked about in detail in section 3.3, this section will focus on building the electronic circuit only. To build the circuit, you only need to follow the following Tinkercad setup, as that is the exact system that powers our product. The circuit can be made on a breadboard or a PCB, whichever is more practical for the person making it.

https://www.tinkercad.com/things/bIQ5rTrtcAY-gng2501-final-product

6.2 Trials & Validation

6.2.1 Prototype 1

For our first prototype, we decided to take 3 different types of fabric and subject them to a variety of care and durability tests to determine which material would be best to use for our final product according to our customer. The 3 materials chosen were a 100% cotton towel, a 100% polyester blanket, and a thin 100% cotton fabric. These materials were chosen for their initial softness and availability/cost, an important concept for the customer. The CPXs that were considered for this prototype are Design for Ease of Maintenance, Design for Comfortable Aesthetics, and Design for Durability. The customer wants a product that is completely or partially waterproof and stain-resistant, and a product that can last for at least a few years.

Figure 19: Materiel Used for Tests

To test the durability criterion, we decided to simulate material wear by rubbing a piece of each material with rough sandpaper for exactly 2 minutes. The worst material performer in this

test was the thin fabric. It lost almost no softness points, but the material tore quite easily, which is unacceptable for our product. After this one, the towel was in second place. It lost quite a bit of material during the test, and its softness quality dropped by 3 points, but it didn't tear. The best material performer was the polyester blanket. It lost enough material during the test, but only lost one point of softness, it was still very soft after the test, which is perfect for what we need. After doing all the durability tests, we decided that the polyester blanket was clearly the best material to use in this category.

To test the ease of maintenance criterion, we have 4 different tests to perform on each material. First, we'll test the impermeability of the materials by soaking them completely in water for a few seconds, and then leaving them to dry to see which dries completely the fastest. Next, we'll stain each material with 3 different products: yellow paint, BBQ sauce, and olive oil. These staining products were chosen for their incredible ability to stain and ruin the textures of most materials; BBQ sauce is good at making materials sticky, oil is good at making materials oily, and paint is good at permanently staining and hardening materials. Each stained material is dried for a few minutes, then cleaned with the same type of stain remover to see which cleans best.

For the waterproofing test, the polyester blanket is the fastest with only 15 minutes for total drying, followed by the cotton towel at 30 minutes, and the thin cotton fabric with more than an hour drying time. The results of this test still show that the polyester blanket is the best material to use for our product. For the final ease of mainteance test (the stain test), we checked the amount of product we put on each material and let them all dry for 2 minutes. After they had dried, we tried to clean each material with cleaner and stain remover for 3 minutes as best we could. To measure this test, we again evaluated the softness of the material after cleaning, as well as its visual appearance per opinion. The material that did best in this test was the polyester cover, which didn't retain as much stain compared to the other materials, and its softness was affected the least. The second best material was the thin cotton fabric, followed by the cotton towel. Once again, the polyester blanket proved to be the best material for our needs.

Table 3. Prototype 1 Test Results

	Final Results		
	Polyester Blanket	**Cotton Towel**	**Thin Cotton Tissu**
Initial Softness	10/10	7/10	5/10
Test 1 : BBQ sauce	10/10	3/10	5/10
Test 2 : olive oil	9/10	5/10	5/10
Test 3 : yellow paint	6/10	3/10	3/10
Test 4 : water resistance	Semi-waterproof	Non-waterproof	Non-waterproof
Test 5 : sandpaper	9/10	4/10	4/10

After all these tests and trials, it's very clear that polyester cover is the best material option for the surface of our product. With this information, we decided to purchase a plush polyester cover as the basis of our product. The customer wants a product that is waterproof, durable, and easy to clean, and with these criteria considered and tested, soft polyester is clearly the best option for her based on the results of our prototype 1 test.

6.2.2 Prototype 2

To test the weight of our product, we need to weigh the prototype with all the selected materials (all the electronics) and have it worn by 4 users for a set period of time (1 hour, for example). It's also important to get their feedback on ease of transport and comfort levels. The success criterion for this test is that the weight should be light enough not to tire the user, while remaining stable during use.

To check that our aesthetic meets requirements, our test will consist in carrying out a subjective evaluation by presenting the prototype to a panel of users (10 users), to gather their opinions on the product's shape, texture and finish. The success of this test will be determined by whether the product's appearance and feel are perceived as soft and reassuring.

To assess ergonomics, we need to test different ways of enlarging the buttons, while ensuring that they still work. In addition, we need to test the amount of force that needs to be applied to the buttons for them to work. The button that is the largest and requires the least force will be the one we use.

The last critical hypothesis we need to test is the implementation of motor servos in the tail of our sensory animal. This is the next one we need to evaluate, and our next prototype. To do this, we need to install the servo motor and test its movement, checking the responsiveness and fluidity of the tail's movements. The criterion for success in this test is that the tail moves smoothly and naturally, without generating too much noise or impacting on the product's portability. We've already started designing two bars that will be used as a sort of skeleton to support the servo motor. These bars will reproduce a fluid, natural movement, similar to that of a dolphin's tail.

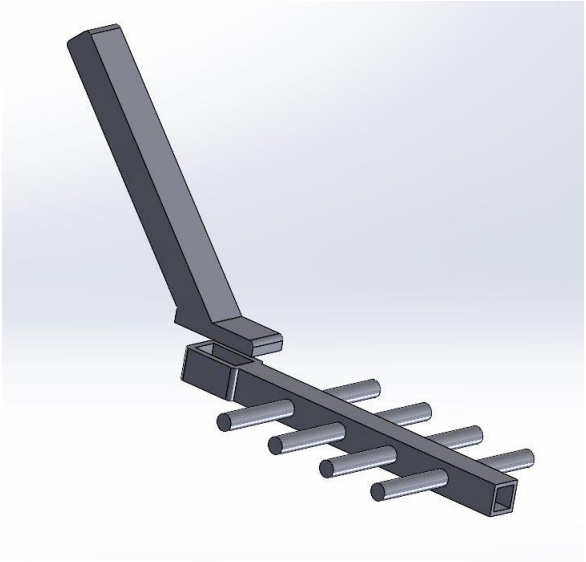

Figure 20: Full Skeleton Sketch

We're also going to integrate the servo motor into our circuit to check that everything's working properly. Before buying the materials, we checked that the battery was strong enough to power the whole circuit. Our initial tests with a multimeter show that the power supply is sufficient. Once the servomotors have been installed, we'll test their responsiveness and synchronization with the rest of the system. The aim is to ensure that all the components work well together without any power or performance problems.

Objectif of Prototype	**Evaluation Criterion**	**Level of Faithfulness**	**Prototype Type**
Integration and milestones	How the circuit works and how much stuffing you can put in the product so that it's cozy but you can still feel the vibrations of the vibrating motor.	Medium	Physical Targeted

Metric	Test Description / Analysis Method	Results	Interpretation
Maximum thickness of stuffing to feel vibrations (in cm)	The idea is to measure the amount of stuffing needed to feel vibrations through the plush. The approach is to add layers of stuffing progressively, testing the intensity of the vibrations felt. If the stuffing is too thin, the vibrations are too strong.	For the vibrations to be felt optimally, we determined that an ideal thickness would be 4 cm of relatively compact stuffing. 	Success, the circuit works

6.2.3 Final Product Tests

Once we've finalized the assembly and the circuitry of our final product, we only had 2 tests to run on it to ensure that the product is ready for it to be presented. The first test was a durability test on the plush and interior components (without electrical parts) where we dropped it from multiple angles from 1.5 meters high to see how long it takes for something to break, and which parts broke first. Our goal for this test was to determine which parts failed first, and where we had to reinforce on the product. We dropped the product many times before something broke, we did the test a few times and found that the structural weak spot was the connection between the ergonomic buttons and the circuitry for it (where the red part connects to the button system itself in the following figure). To reinforce it, we added more padding to the area, and made sure the button didn't extrude too much from the mounting system. After these modifications, it took much longer for anything to break in the product, so we considered the test and the fix to be successful.

Figure 21: Connection Between Button and Circuitry Without Ergonomic Add-on

For our second test, we wanted to focus more on the electrical durability of the product. This test is similar to the last one, as we simply activate and deactivate each module multiple times until a malfunction of breakdown occurs. For this test, the goal was once again to determine which module fails first, and where the circuit can be reinforced both physically and electronically. The results of the test were very good for the servo motor, but the MP3 module occasionally activated on its own once the circuit initially got power, and the vibration motors' wires disconnected due to the vibrations after 30-40 activation cycles on average. To solve the MP3 problem, we changed the code for the MP3 module so that its initial state once it receives power is to be deactivated, to prevent any unintentional activations. To solve the vibration motor problem, we made sure to attach the motors properly so they wouldn't disconnect or break off no matter how often they get activated. After these problems were resolved, we considered both the test and its fixes to be a success.

7 Conclusion and Recommendations for Future Work

Throughout the development of the Sensory Animal device, we applied a rigorous design thinking approach, drawing on interviews and testing to refine our prototype. This project allowed us to understand the importance of iteration and adaptability in designing an interactive product.

Thanks to a modular design, we were able to efficiently integrate various features such as vibrations, sounds, and movements, while ensuring an intuitive sensory experience. The process also taught us how to balance innovation and simplicity to ensure a functional and ergonomic product.

Several future improvements are possible. Optimizing battery life, integrating even more durable and washable materials, and refining the sensors for smoother interaction are promising avenues. Furthermore, expanding testing with experts and end users would allow us to further refine the product to ensure its effectiveness and durability.

This experience has strengthened our ability to transform an idea into a concrete prototype, while taking into account technical constraints and user needs. The Sensory Animal has the potential to evolve further, paving the way for a more advanced version better adapted to the specific needs of users.

8 APPENDIX

Makerepo Link: Sensory Animal Dolphin - Team Douxphin Inc. (FC2-1) | MakerRepo

User's Guide Video Link: https://youtu.be/lF-V0ku7sZ4

8.1 Arduino Code

```
#include <SoftwareSerial.h>
#include <Servo.h>

SoftwareSerial mp3Serial(10, 11); // RX (MP3 TX), TX (MP3 RX)

const int vibrationButton = 3;
const int motorPin = 9;
const int buttonPin = 2; // MP3 Button
bool isPlaying = false;
bool motorState = false;
unsigned long lastDebounceTime = 0;
const int debounceDelay = 200;

Servo myServo;
const int servoPin = 6;
const int servoButtonPin = 4;
unsigned long lastServoDebounceTime = 0;

void sendCommand(byte command, byte param1 = 0, byte param2 = 0) {
  byte message[] = {0x7E, 0xFF, 0x06, command, 0x00, param1, param2, 0xEF};
  mp3Serial.write(message, sizeof(message));
  delay(500);
}

void setup() {
  Serial.begin(9600);
  mp3Serial.begin(9600);

  pinMode(buttonPin, INPUT_PULLUP);
  pinMode(vibrationButton, INPUT_PULLUP);
  pinMode(motorPin, OUTPUT);

  Serial.println("MP3 Player Ready...");
  sendCommand(0x06, 0, 20);  // Set volume

  pinMode(servoButtonPin, INPUT_PULLUP);
  myServo.attach(servoPin);
```

```
  myServo.write(90); // Neutral
  myServo.detach(); // Detach immediately after setting position
}

void loop() {
  // MP3 Button
  int buttonState = digitalRead(buttonPin);
  if (buttonState == LOW && (millis() - lastDebounceTime) > debounceDelay) {
    lastDebounceTime = millis();
    if (isPlaying) {
      sendCommand(0x0E); // Pause
      Serial.println("Paused");
    } else {
      sendCommand(0x0D); // Play
      Serial.println("Playing");
    }
    isPlaying = !isPlaying;
  }

  // Vibration Button
  static unsigned long lastVibDebounceTime = 0;
  bool currentVibrationButtonState = digitalRead(vibrationButton);
  if (currentVibrationButtonState == LOW && (millis() - lastVibDebounceTime) >
debounceDelay) {
    lastVibDebounceTime = millis();
    motorState = !motorState;
    digitalWrite(motorPin, motorState ? HIGH : LOW);
    Serial.print("Vibration Motor: ");
    Serial.println(motorState ? "ON" : "OFF");
  }

  // Servo Button
  bool currentServoButtonState = digitalRead(servoButtonPin);
  if (currentServoButtonState == LOW && (millis() - lastServoDebounceTime) >
debounceDelay) {
    lastServoDebounceTime = millis();
    Serial.println("Servo button pressed!");

    myServo.attach(servoPin); // Attach when needed
    myServo.write(135); // 45° CW
    delay(250);
    myServo.write(45); // 90° CCW
    delay(250);
```

```
    myServo.write(90); // Neutral
    delay(250);
    myServo.detach(); // Detach to stop twitching
  }

  delay(50); // Short debounce
}
```