Jessica Monteleone | Hannah Smythe

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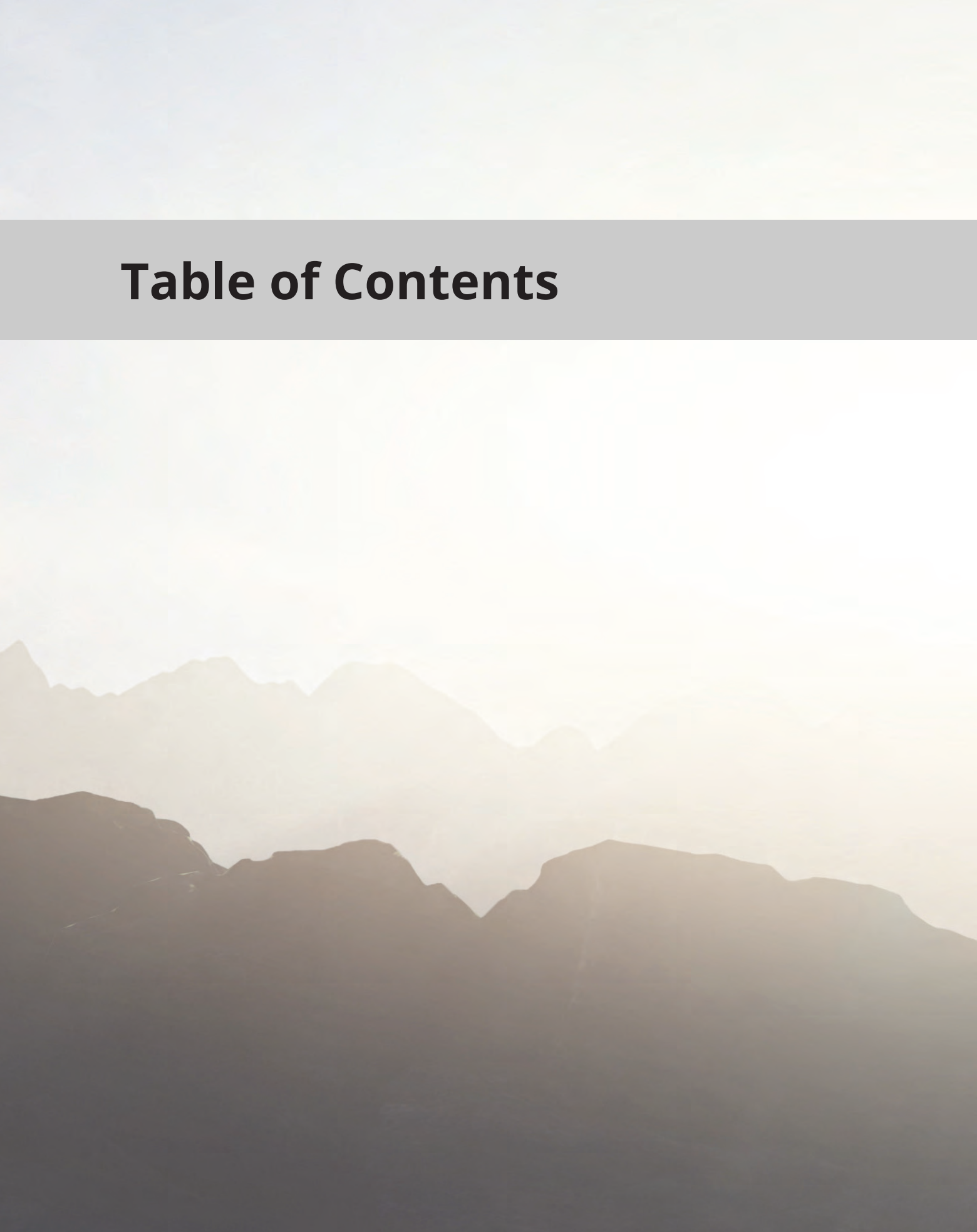
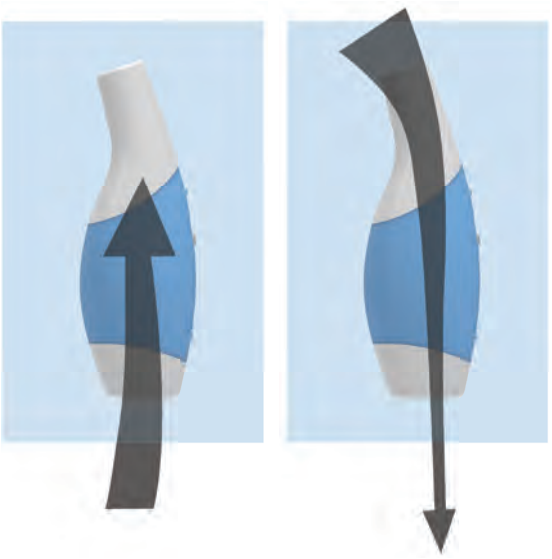


Overview

A portable and discreet assistive breathing device to reduce the severity, duration, and frequency of panic attacks.

Panic Attack **Relief & Prevention**

Para is a handheld focus object designed with the support of medical professionals to help create a natural calming response. Para utilizes breathing exercises with soothing vibration feedback to help alleviate the symptoms of a panic attack and assist with mindfulness exercises.



A valve system allows users to inhale fully through the device while restricting and lengthening their exhale. This accounts for the hyperventilation that often occurs during a panic attack. Para is able to detect breathing to provide personalized vibration feedback when the user exhales. This encourages the user to lengthen their exhale.

Para is an effective assistive breathing device for use during panic attacks and mindfulness exercises because it successfully fulfills 3 main criteria:

FOCUS OBJECT & ACTIVITY
an object to ground the user and an activity to distract

PORTABLE & DISCREET
always accessible and able to be used in public

LENGTHENS EXHALE
creates a neurological calming response

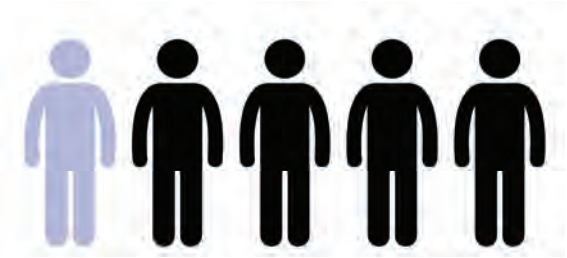
A worry stone thumb groove provides an additional tactile element to calm the user.

Research

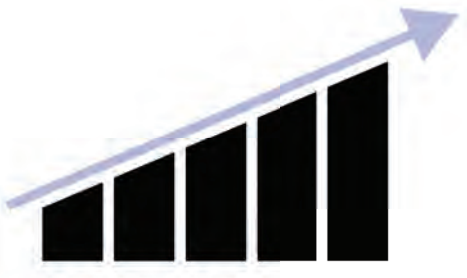
Mental Health **Importance**

Mental health became an area of focus due to personal experiences and the desire to change the stigmas surrounding the topic. We began to wonder how we might use a **physical product** to aid a primarily **psychological condition.**

According to the **National Alliance on Mental Illness** (NAMI):



1 in 5 adults in the United States experience mental illness



People with serious mental illness are **twice as likely to develop cardiovascular and metabolic diseases** than the general population

Stigmas associated with mental illness often discourage individuals from seeking treatment. Only 43% of adults in the U.S. with a mental illness receive treatment.

Across the U.S. economy, serious mental illness causes $193.2 B in lost earnings each year

Depression and anxiety disorders cost the global economy $1T in lost productivity each year

National Alliance on Mental Illness (NAMI): Ways to Fight Mental Health Stigma

- Talk openly about your mental health
- Educate yourself and others
- Understand what you might not understand
- Equality between physical and mental illness
- Spread mental health awareness


EDUCATION

Mental health days for students: An increasingly accepted reason to stay home from school

- USA Today, 2019


STUDENTS AND SOCIAL ISSUES MENTAL HEALTH/TRAUMA

SEPTEMBER 27, 2019 • 9:39AM

1.2K 3

Stigma Buster: Schools Look at Mental Health Days for Students

- National Education Association, 2019

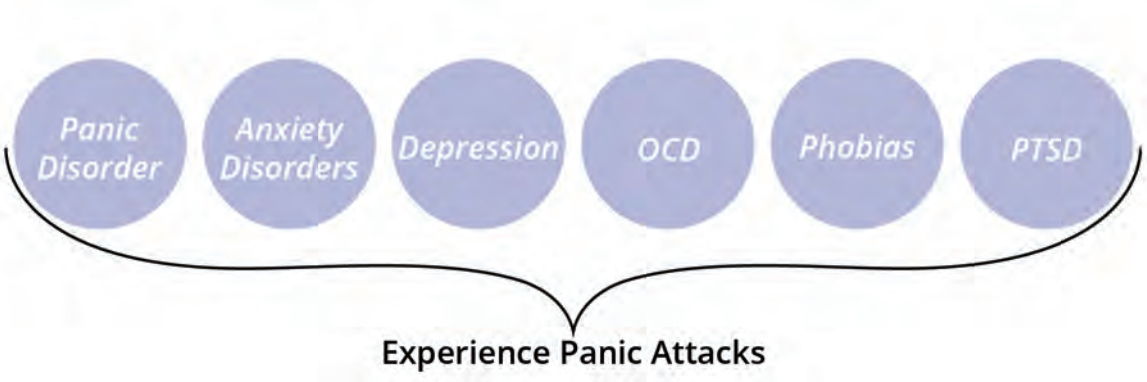

Health

Schools now letting students stay home sick for mental-health days

- The Washington Post, 2019

Mental Illness & Panic Attacks

There are numerous struggles that people with mental illnesses face, but one common hardship is the panic attack. Panic attacks affect a large group of people and are not confined to one mental illness. Creating a product in the realm of panic attacks will allow us to assist a larger group of people.



What is a Panic Attack?

An activation of your body's **fight-or-flight mechanism**

A panic attack is a **sudden episode of intense fear** that triggers severe **physical reactions** when there is **no real danger** or apparent cause

Symptoms of panic attacks are both physiological and psychological.

"A panic attack is intense fear or anxiety that may make you short of breath or dizzy or make your heart pound. You may feel out of control. Some people believe that they are having a heart attack or are about to die." - Michigan Medicine

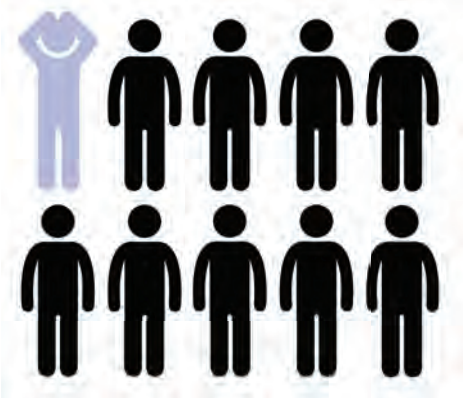
Physiological Symptoms:

- Pain in Chest
- Trouble Breathing
- Hyperventilation
- Dizziness
- Blurred Vision
- Headaches
- Sweating
- Numbness
- Trembling

Psychological Symptoms:

- Absolute Terror
- Extreme Anxiety
- Loss of Control
- Fear of Heart Attack
- Fear of Death
- Tunnel Vision
- Inability to Think Clearly
- Hopelessness
- Detached from Reality

Panic attacks vary from person to person. The experiences can be any combination of the symptoms listed above. While some people may have triggers that cause panic attacks, a majority of panic attacks are spontaneous with no clear cause.



1 in 10 Americans experience a panic attack each year

Americans experience panic attack symptoms every month

Panic Attack Experience

To understand the experience of a panic attack, we needed to hear first hand accounts. To do so, we reached out to the Philadelphia chapter of the National Alliance on Mental Illness (NAMI) as well as Jefferson University students.

Experience Network:

National Alliance on Mental Illness
Mental Illness Support Group
- Members with diverse backgrounds and mental illness histories
- Allowed us to observe and participate in support group meetings

Amy Federer
NAMI Philadelphia Coordinator
- Organized all interactions and meetings with NAMI
- Provided insight into the group as well as personal experiences

Carly Hester
NAMI Philadelphia Manager
- Provided personal insight and experiences
- Provided insight into struggles of children with panic and anxiety

Students | Jefferson University
Panic Attack Experience
- Students with diverse backgrounds and mental illness histories
- Provided personal insights and experiences

We were able to gain a better understanding of the physical and psychological effects of panic attacks by listening to the experiences shared by NAMI members and Jefferson University students.

I thought I was having a **heart attack**

It feels like I am **suffocating**

It feels like my brain is shutting down and going into overdrive at the same time

Severe and excruciating tunnel-vision

I can't get out of my own head

I become a prisoner to my own mind. It just takes over. **I am not in control of my body.**

I couldn't pinpoint what started it, what prompted the rush of color to my face, the shortness of breath, the quick onset of intense fear. But I began sobbing, wrapped my arms around my body, and hurried back to my room.

Panic Attack Stages & Symptoms

While panic attacks vary, the majority of panic attacks progress through three main stages: onset, peak and recovery.

Onset Symptoms:

Heart Rate Increases
Breathing Accelerates
Adrenaline Rush
Fear Heightens
Sense of Dread

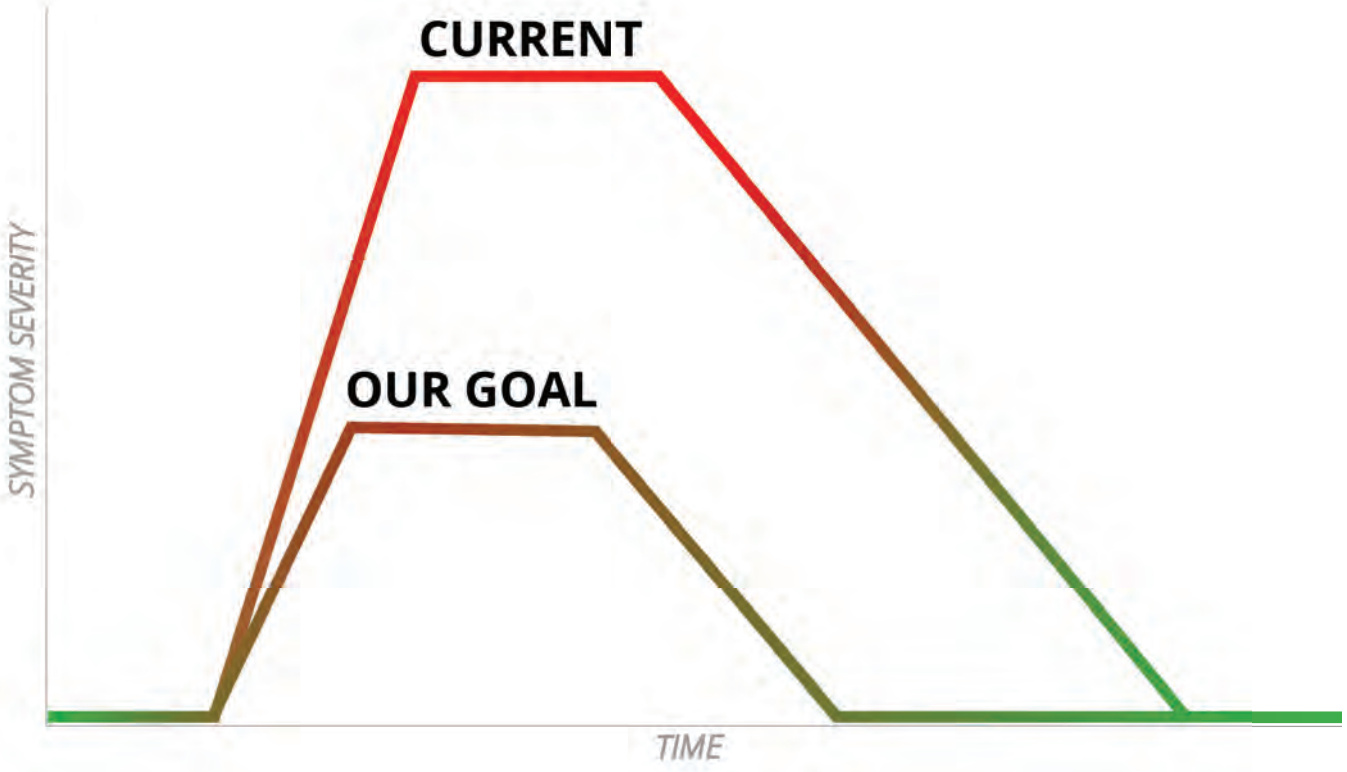
Peak Symptoms:

Hyperventilation
Feelings / Fear of Death
Intense Sweating
Head Spinning
Nausea
Chest Pain

Recovery Symptoms:

Breathing Normalizes
Heart Rate Decreases
Mental Decompression
Feeling of Exhaustion

Project Goal



We aim to mitigate the effects of a panic attack early, resulting in a **less intense peak** with reduced symptom severity, as well as a **faster recovery time.**

To understand how to best intervene to accomplish our goal, we will need to better understand the science behind a panic attack, as well as the pros and cons of existing solutions.

Panic Attack Treatment

In order to achieve our goal, we need to understand the current methods used to resolve panic attacks.

Psychological Grounding

Directing focus to physical sensations or surroundings rather than the thoughts causing anxiety or panic.

This can be done by **focusing on a particular object** or noting surroundings in detail. **Grounding can be used during an attack and preventively.**

Example:
Acknowledge 5 things you can see, 4 things you can touch, 3 things you can hear, 2 things you can smell, and 1 thing you can taste

Breathing Exercises

Deep and regular breathing helps to treat and prevent panic attacks.

An **exhale** lasting longer than the inhale activates a **neurological calming response** in the body. Breathing and mindfulness exercises can be **used preventatively or during an attack**.

Example:
Breathe in for 4 seconds, hold the breath for 7 seconds, and then exhale for 8 seconds

Medication

There are acute medications for spontaneous use as well as preventative medicines that are taken daily.

There are still many **psychological barriers** to overcome that **medications cannot fix**, and many people are hesitant to take medication regularly due to **potential side effects** or the possibility of addiction.

Example:
Selective serotonin reuptake inhibitors (SSRIs) like Zoloft and Lexapro, or benzodiazepines like Xanax and Valium

Therapy

A psychological approach to treating many mental illnesses that generally requires regular meetings with a professional.

Therapy often involves learning about mental health conditions, becoming aware of associated thoughts and emotions, and **recognizing and reshaping negative thinking**. It also involves finding techniques to **cope with stressors and relax.**

Example:
Cognitive behavioral therapy (CBT)

Panic Attack Treatment

After researching current methods of treatment, we were able to identify areas of opportunity that current treatment methods do not adequately address.

Flaw of solely using medication or therapy:

> There is a **physiological component** behind panic attacks that is **not addressed by drugs or therapy — chronic hyperventilation.**
>
> - Palo Alto Health Services

We do not intend to replace medicine or therapy. Our product is aimed to fill the gaps that cannot be addressed by current medication or therapy.

Hyperventilation & Panic Attacks:

"**Panic and hyperventilation** are postulated to **reinforce each other** by a positive feedback loop. Treatments directed at any part of this loop are likely to be successful."
- Deborah S. Cowley M.D.

"In order to learn to **cope with hyperventilation**, it can help to do **regular breathing and relaxation exercises**... Learning to breathe slowly and deeply is especially important for people with hyperventilation."
- Derbyshire Community Health Services

Within the category of mental illness lies panic attacks. Inside of panic attacks, there are options that offer treatment or prevention. We aim to find a solution that not only treats an attack, but can be used as a preventative measure as well.

Breathing is a critical component of treatment and prevention

Panic & Anxiety **Market**

Initial market research found many diverse products claiming to treat panic or anxiety. This created a confusing competitive landscape, which made it difficult to draw conclusions from the research.

Categorizing existing solutions into six main groups allowed us to better organize our thoughts to identify general pros and cons across seemingly different products.

Single Device Biofeedback:
Pros: Compact and gives direct feedback on condition
Cons: Current options are not discreet and do not aid breathing

Physical Breathing Device:
Pros: Helps regulate breathing, which is proven effective
Cons: Not able to provide feedback and is not discreet

Electrical Stimulation:
Pros: Scientifically based relief approach
Cons: Not discreet, intimidating and uses extreme technology

Physical Monitor & Digital Relief:
Pros: Allows user to track progress on personal device
Cons: Phone usage is a trigger and monitors more than relieves

Tactile Relief:
Pros: Stimulates multiple senses and can be subtle
Cons: Does not provide enough relief on its own

Apps:
Pros: Everyone can access these options easily
Cons: Phone usage is a trigger for many people

Professional Network

We knew we needed the insight of professionals to narrow our project focus, as our market research presented many different product categories that had the potential to assist with panic attacks. We did not know enough about the medical and psychological considerations of the categories to make an informed decision, so it was necessary to reach out to professionals with relevant knowledge and experience.

Dr. Glenn Rosen
Primary Care Physician
Has interacted with anxiety patients daily for 16 years

"It all starts with the breath. **Treating breathing and hyperventilation** will effectively treat the panic attack"

"**Preventative exercises** that teach you how to breathe are great. Whether having attacks or not, some people haven't taken a deep breath in 10 years. It would be great to have a breathing device that can be used acutely and preventatively"

Dale Michaels
Counselor, Psychologist
Expert in the field of depression and trauma

"Reset the nervous system through **deep breathing**"

"It is important to **give the user something else to focus on**"

"Make sure there's an extra component that moves focus away from just breathing. Completely focusing on breathing could be counterproductive for someone having a panic attack. Try stimulating senses."

Dr. Jenna Rieder
Psychologist/ Neuroendocrinologist
Expert on the neurological components of stress

"Your **exhale** is linked to your parasympathetic nervous system which **helps calm you down**. A person should exhale for longer than they inhale to activate the vagus nerve within the parasympathetic nervous system. This is needed for your body to function normally"

"**Preventative exercises are worthwhile**, and could fix abnormal breathing patterns"

Colleen Zane
Occupational Therapist
Specializes in behavioral health conditions

"**Hyperventilation is physiological and psychological**. It affects your body function and makes you feel like you are dying."

"It helps to have **something to focus your breath on**; like blowing bubbles with kids. Lots of my clients smoke because it is relaxing to see their breath. It helps you feel empowered that you have some level of control."

Key Takeaways:

Control breathing & hyperventilation to treat an attack

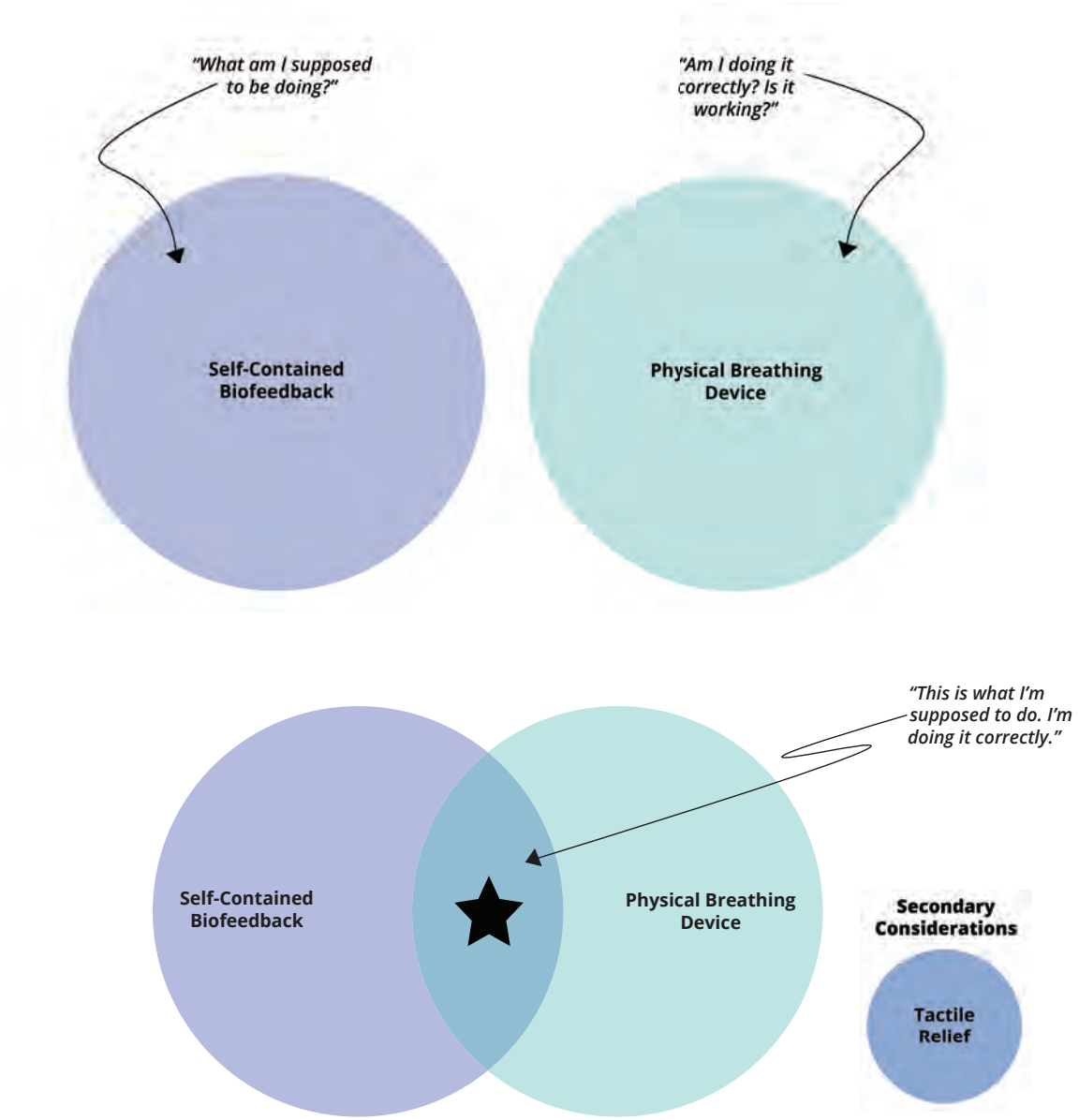
Lengthen exhale to calm the nervous system

Focus on something else (not breathing) to calm an attack

Frequent breathing exercises can have long term benefits

Panic Attack **Market Narrowing**

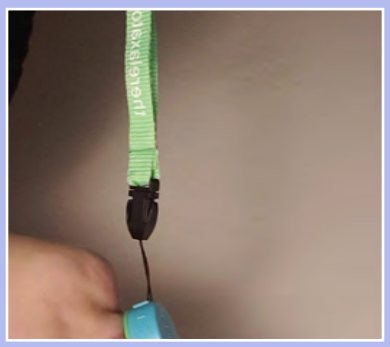
After receiving insight from professionals, we knew it would be most beneficial for our product to be a physical breathing device that gives feedback.



By combining the two, we can walk the user through what they are supposed to be doing, as well as reassuring them that they are doing it correctly. Feedback gives the user something to focus on. While tactile relief is not the main focus of the device, it became an important aspect to incorporate in the final design to assist calming.

CalmiGo

The Shift



The Relaxator

We tested 3 breathing devices claiming to treat panic attacks or anxiety. Evaluating our direct competition allowed us to gain a better understanding of the positive and negative aspects of each feature to make more informed design decisions.

FEATURES	CalmiGo	The Shift	The Relaxator	SUPPORT FOR FEATURES		
	$179.20	$85-$115	$35	Market	Professionals	User
Physical Breathing Aid	✓	✓	✓	✓	✓	✓
Focus Object	✓	✓		✓	✓	✓
Focus Activity	✓	✓	✓	✓	✓	✓
Provides Tactile Relief				✓	✓	✓
Contains Scented Element	✓					
Takes Preventative Measures	✓	✓	✓	✓	✓	✓
Tells You How to Use	✓			✓	✓	✓
Uses Reminders				✓		
Has Progress Tracking				✓		
Gives Realtime Feedback				✓	✓	✓
Shows Breathing					✓	✓
Shows Heart Rate				✓		
Discreet		✓		✓	✓	✓
Can Use in Public		✓		✓	✓	✓
Portable	✓	✓		✓	✓	✓
Welcoming Form		✓				✓
Simple Interaction		✓		✓	✓	✓
Uses One Device During Attack	✓	✓	✓		✓	✓
Considers Hyperventilation					✓	✓
For Use During Attack	✓	✓		✓	✓	✓
For Use Not During Attack	✓	✓	✓	✓	✓	✓

To prioritize the features to include in our design, we compared our test results to evidence of important features across the market, information collected from medical professionals, and needs specified by the potential end user.

Main Relief Options

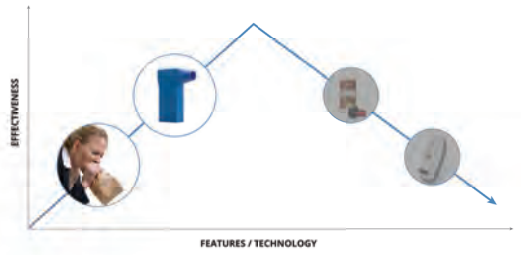
The spectrum of panic attack relief products, as well as our opportunity, can be seen by analyzing four main relief options.

Paper Bag:
Stereotypical Breathing Regulation
- Visualization of Breath
- Embarrassing
- Placebo Effect

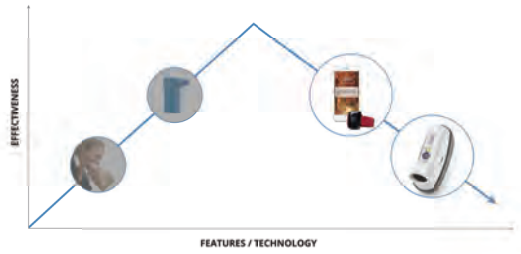
Bcalm:
Carbon Dioxide Scrubber
- Slightly More Discreet
- Not scientifically accepted as helpful
- Limited Use before disposal

Ario:
Wearable Stress Monitor
- Discreet
- Monitors panic, but does not assist calming
- Phone Usage to communicate can be a trigger

Calmigo:
Anxiety Breathing Device
- Incorporates longer exhales
- Over stimulating - heavy vibrations, flashing lights, rattling and scents

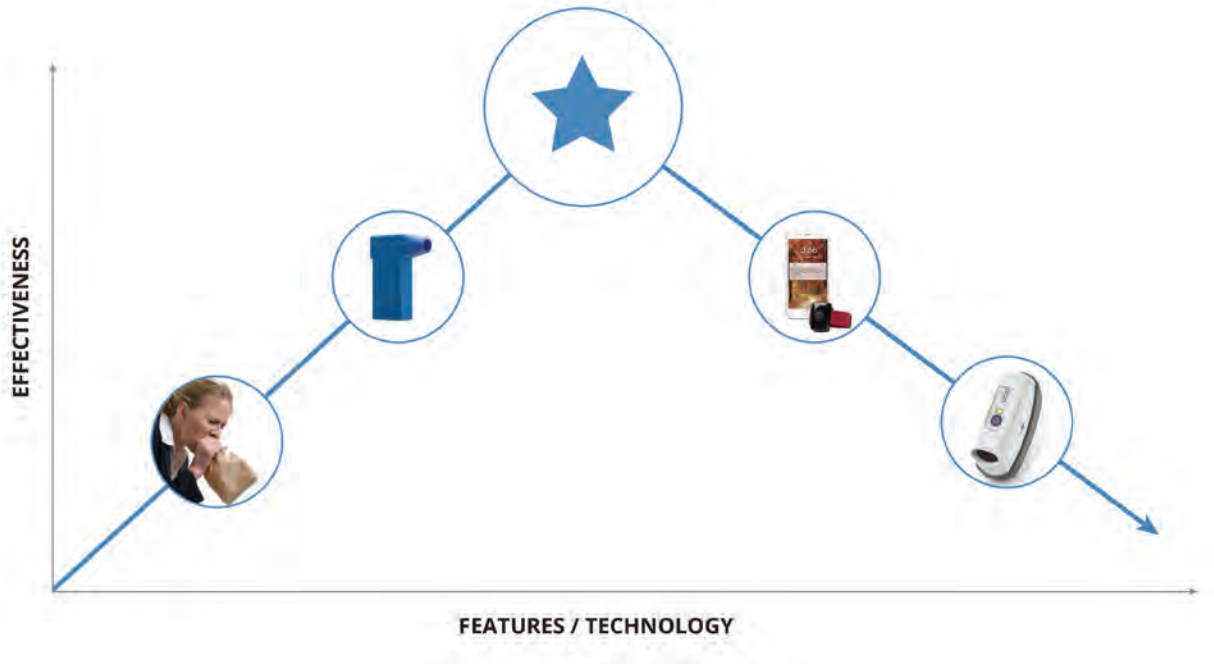


Ineffective:
- Overly simple
- Not backed by accepted science



Ineffective:
- Complexity triggers users
- Poor user interaction because of excessive features

Opportunity



There is an opportunity to create a device that incorporates the right balance of features and technology to optimize effectiveness without being overly complicated.

Design Criteria

The culmination of all our research allowed us to prioritize three main criteria that must be executed for our device to be successful.

FOCUS OBJECT & ACTIVITY

provide a physical object to help ground the user, and a focus activity to distract their mind from their panicked state

PORTABLE & DISCREET

panic attacks can happen anywhere, so the device must always be accessible and able to be used discreetly in public

LENGTHEN EXHALE & ACCOUNT FOR HYPERVENTILATION

allow a full inhale (in the case of hyperventilation) while restricting and lengthening exhale (to create a neurological calming response)

Key Considerations

In addition to our primary design criteria, our research resulted in many secondary considerations that will influence our design process.

NO PHONE USAGE

phones are often a source of anxiety to people who experience panic attacks

TACTILE ELEMENTS

assist with grounding a user by giving them something that they can feel and focus on

UNCOMPLICATED INTERACTION

people experiencing attacks have limited mental capacity so it is crucial to simplify processes

PREVENTATIVE EXERCISES

encouraging correct breathing on a regular basis can provide long term improvement

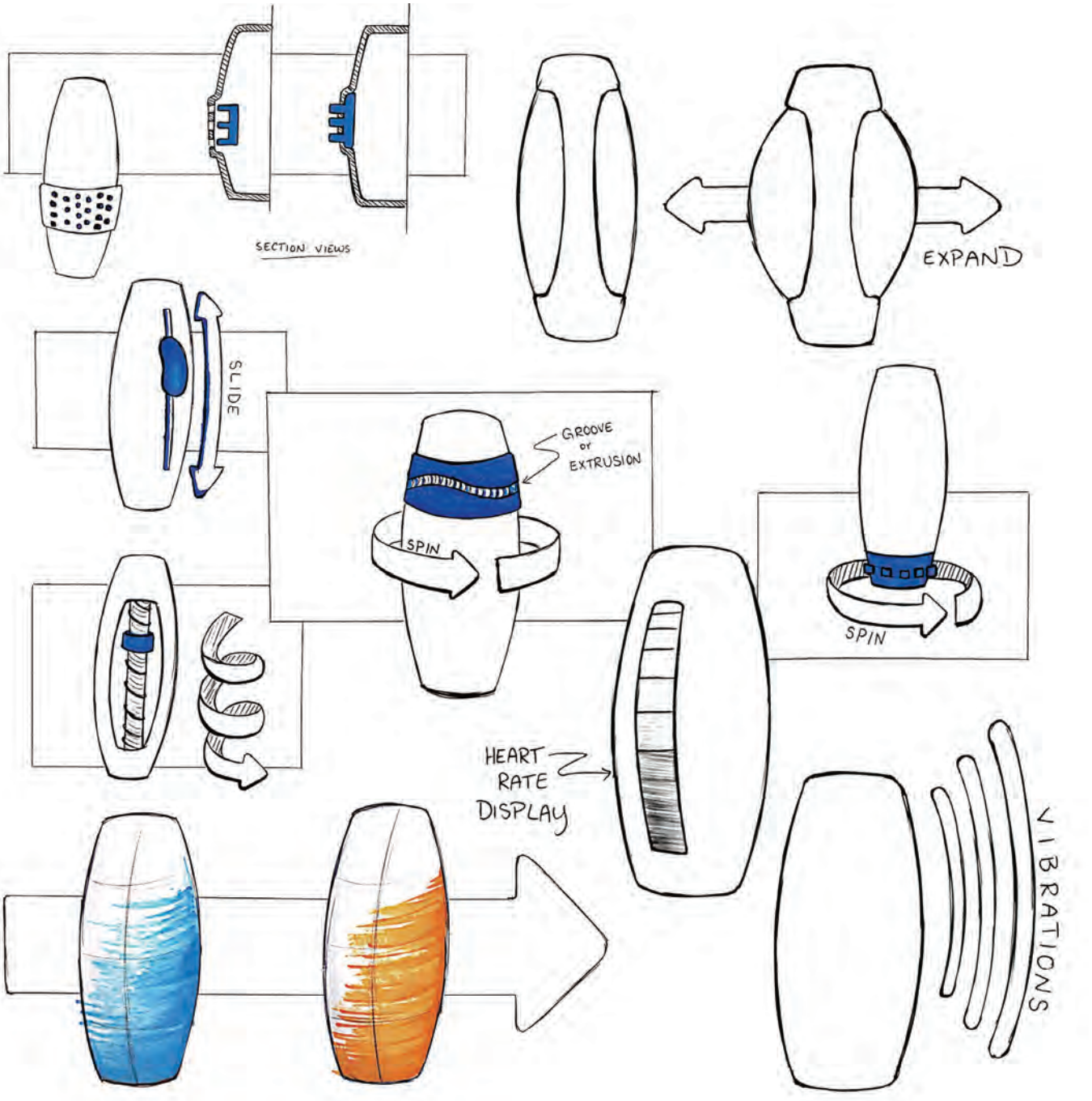
DURABLE

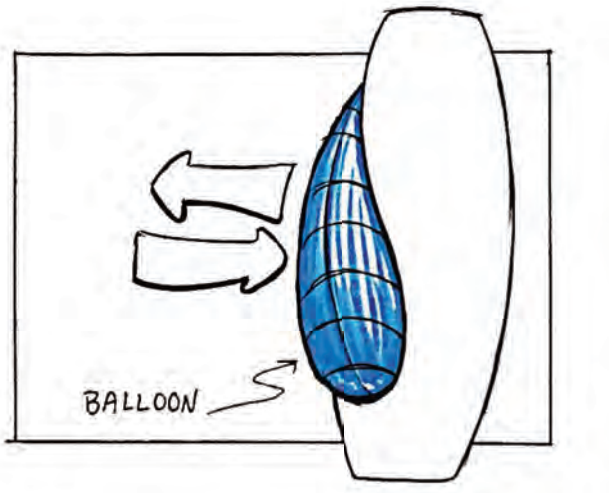
attacks can happen anywhere so the device must be transported in purses and bags without damage

Development

Ideation: **Focus Activity**

When beginning our ideation, we knew we must find a way to turn a user's breathing into a focus activity. This required having the device respond to their breath. We sketched ways that this could be possible. We also created very basic prototypes for some of the possible focus activities.

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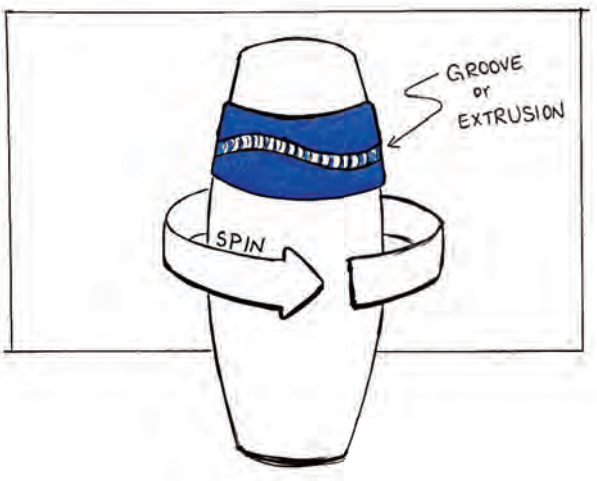
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or
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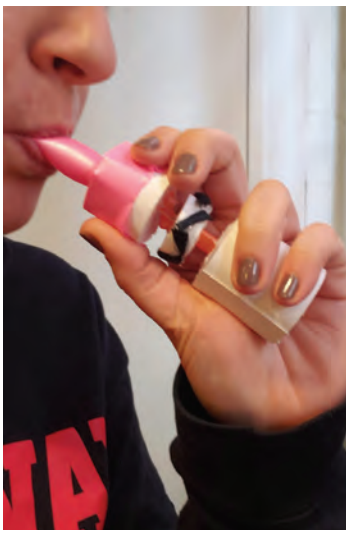

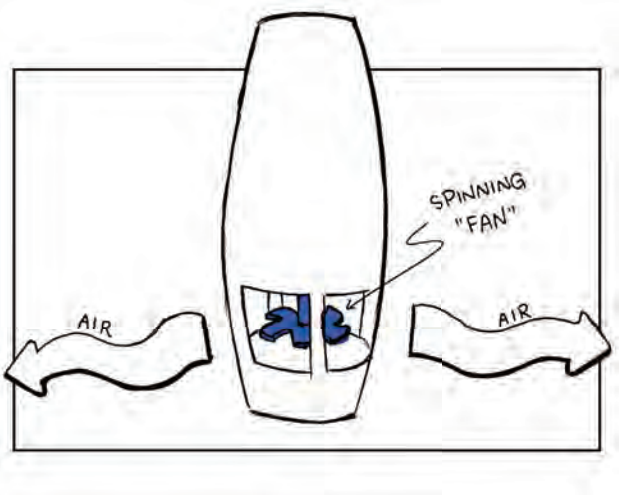
SPINNING
"FAN"
AIR
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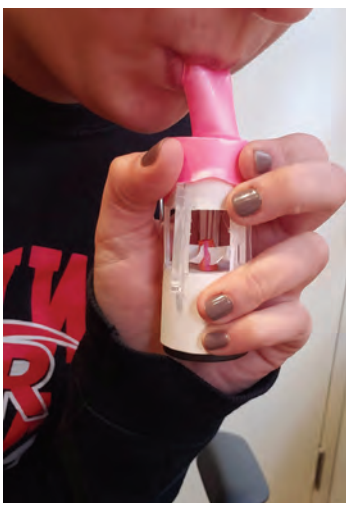
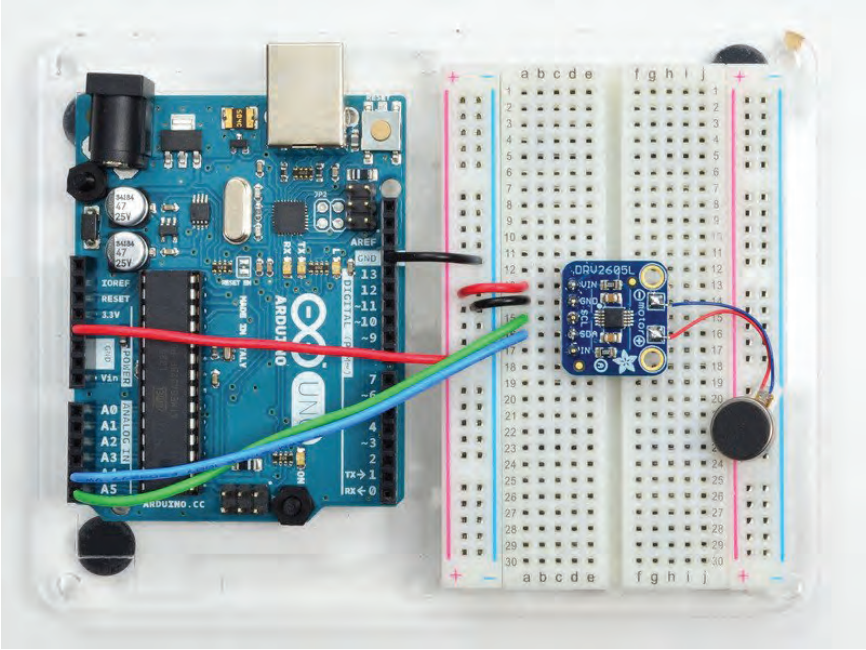


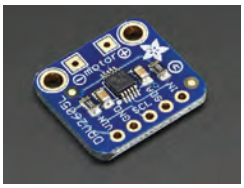
Focus Activity: Vibrations

The initial prototypes led us to decide that the vibrations would be the most effective form of feedback because they could be best controlled to create slight variations.

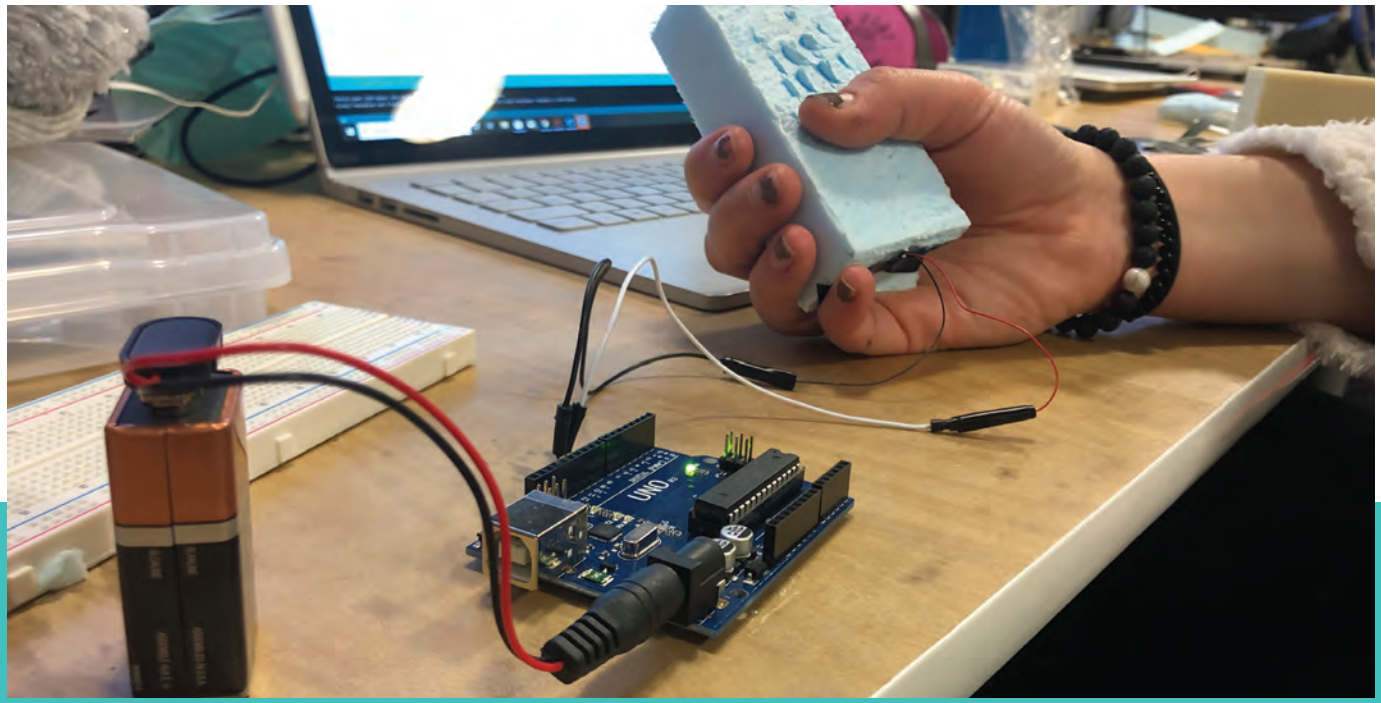


By selecting vibrations as our focus activity, we can control them by creating our own code and using a haptic driver. There is less room for error since we can have the vibrations respond exactly how we want them to.

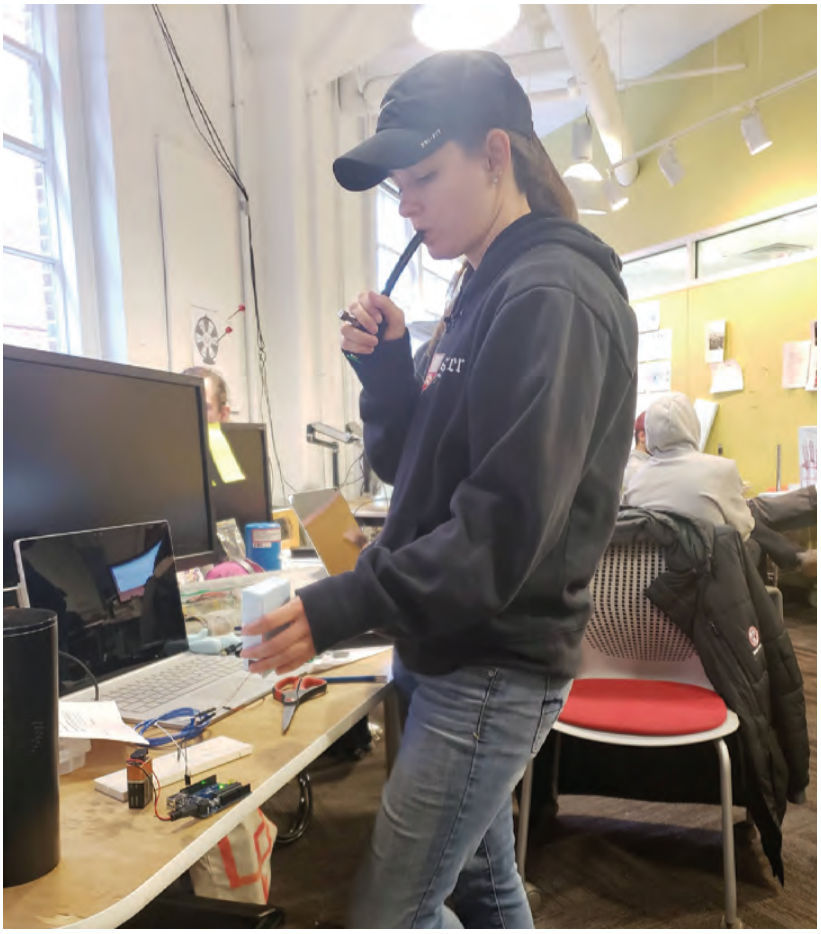
Vibration Motor



Haptic Driver



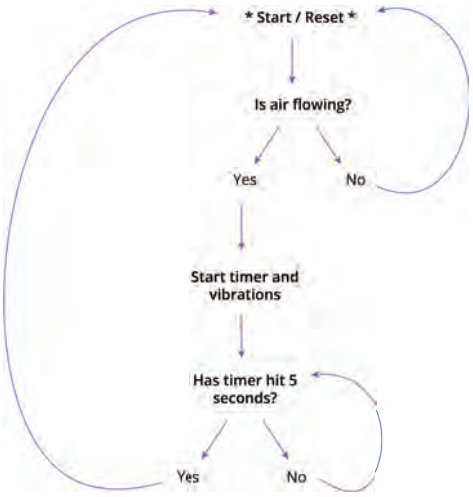
We created the basic circuit and placed the vibration motor in blue foam. This diffused the vibration intensity and allowed the motor to be easily held.



```
void loop() {

  // read state of pushbutton
  buttonState = digitalRead(buttonPin);

  //start timer
  unsigned long currentMillis=millis();

//if pushbutton is pressed
  if (buttonState == HIGH) {

    //if button is pressed for exhaleTimeMax
       if ((unsigned long)(currentMillis - previousMillis) >= exhaleTimeMax) {
         //vibrate
         digitalWrite(vibrationPin, HIGH);
         delay(1000);
         digitalWrite(vibrationPin, LOW);
         delay(500);
         //reset time
         previousMillis = currentMillis;

       } else {

         //start main vibration sequence
       drv.go();
  }

  } else {
  //if button is not pressed
  //reset time
    previousMillis = currentMillis;
    }
  }
```

With a few lines of code and our makeshift vibration prototype, we began testing to see if we could match our breathing to timed vibration intervals. We exhaled through a tube to slightly restrict our exhale while testing.

We began to wonder if it would be possible to use a sensor to detect breathing and alter vibrations based on the data from the sensor. If so, the vibrations could be personalized and more accurately guide users through breathing exercises.



Can the user's breathing directly control the vibrations they feel? Can vibrations influence the user's breathing?

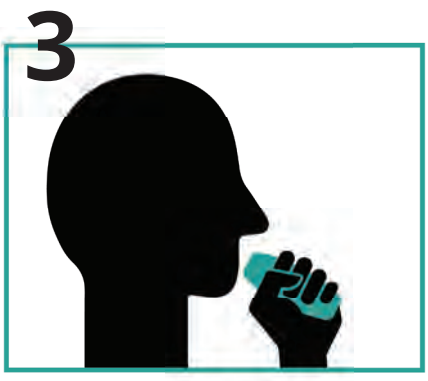
Initial **Storyboard**

We wanted to investigate having two modes; one for panic attacks and one to do breathing exercises as a way to prevent panic attacks.

Mode 1
For Panic Attacks

Panic Attack Onset

Grab Device,
Choose Mode 1

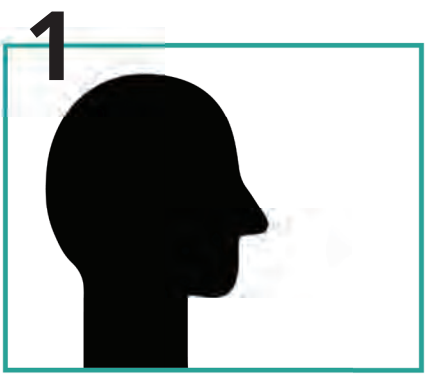


Breathe Through Device

Vibrations Controlled
by Breath

Benefits: vibrations are personalized to the user's breathing to give the user a sense of control, even during hyperventilation
Considerations: device requires some sort of breathing detection

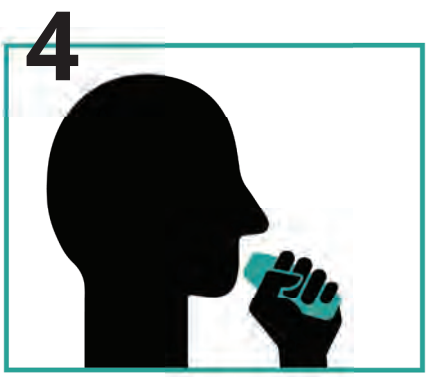
Mode 2
For Mindfulness



User in Calm State

Grab Device,
Choose Mode 2

Feel Vibrations



Match Breathing
to Vibrations

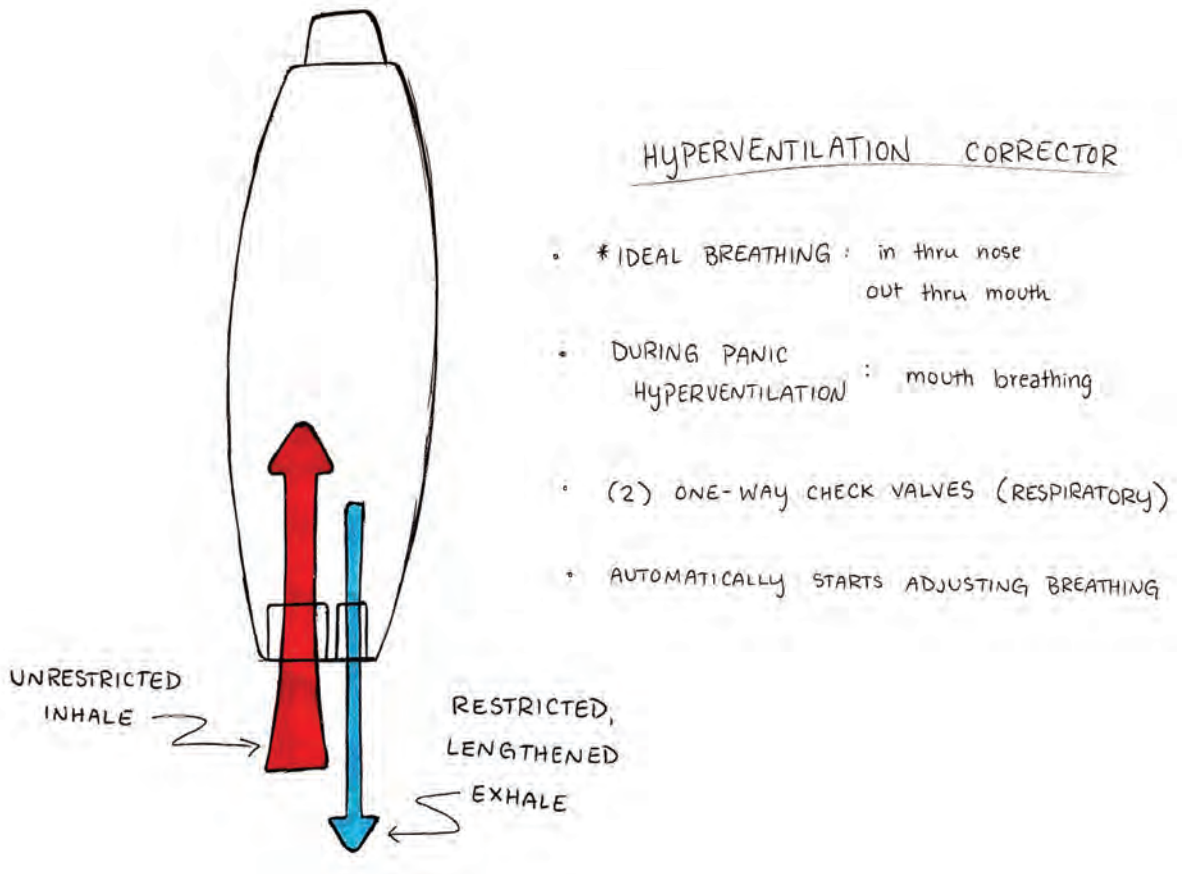
Benefits: the user has a clear breathing goal to focus on and can use the mode during mindfulness exercises
Considerations: Does the duration of inhale/exhale need to be customizable? If the user is hyperventilating, timed cycles won't work

Initial **Air Flow**

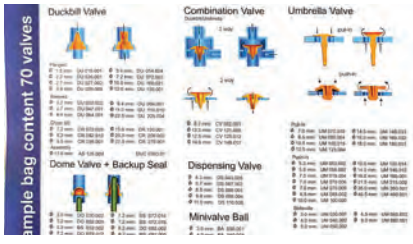
Through our research, we knew that the user's exhale must be restricted to activate the parasympathetic nervous system. Accounting for hyperventilation means the user must get a full breath of air in through the device. We had to find a way to restrict the exhale while allowing a full inhale.

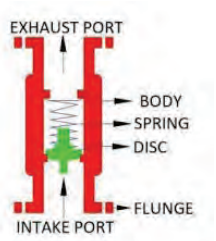
Hyperventilation Requires Full Inhale

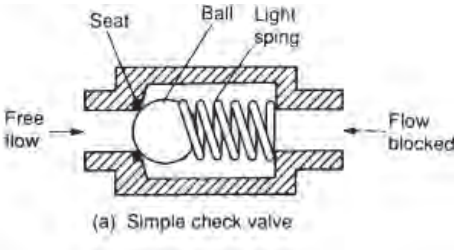
Relief Requires Restricted Exhale



We began researching and testing different types of dual flow valves to form a better understanding of how they function. We were trying to see if there was a pre-existing valve that could be incorporated into our device or if a custom valve would have to be made.







Initial **Air Flow**

After observing existing valves, it became apparent that we would have to create our own dual flow valve. In order to do so, we had to find the ideal inhale and exhale volumes.

Using Exercise to Test Air Flows

We thought exercise would be a good method to test the breathing volume. Rapid breathing caused by exercise would simulate hyperventilation. We verified this with the doctor in our network. We gathered straws and tubes with different inner diameters. They would be used to breathe through as a means to test air volume.

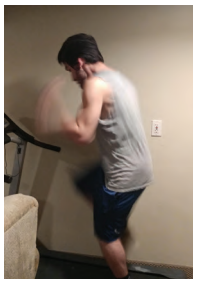
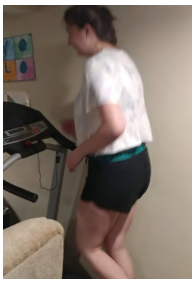
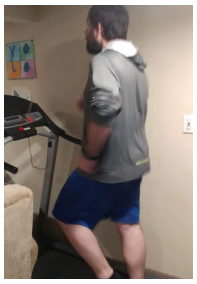
Once we find a non-restrictive inhale diameter and a comfortably restricted exhale diameter, we can move forward with valve designs.

Subjects Will:

Run and get their heart rate up

Test straws for ease of inhale

Test straws for comfort of exhale restriction

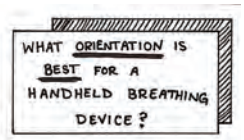


Key Takeaways:

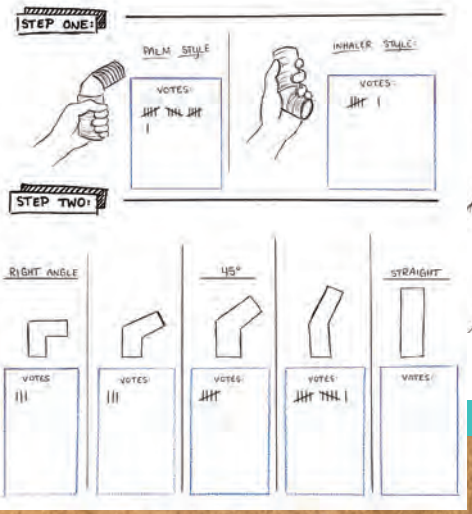
- Ideal Inhale Diameter: 1/2”
- Ideal Exhale Diameter: 1/4”

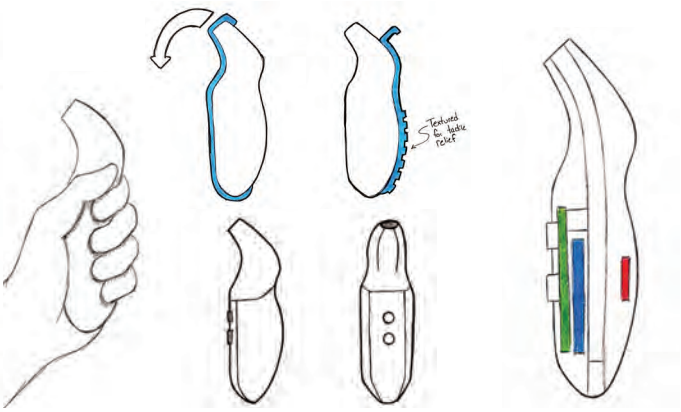
Initial **Form Development**

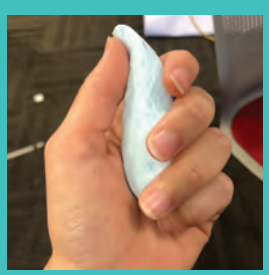
Once device's function was known, we were able to begin developing the form.

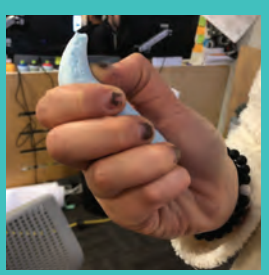


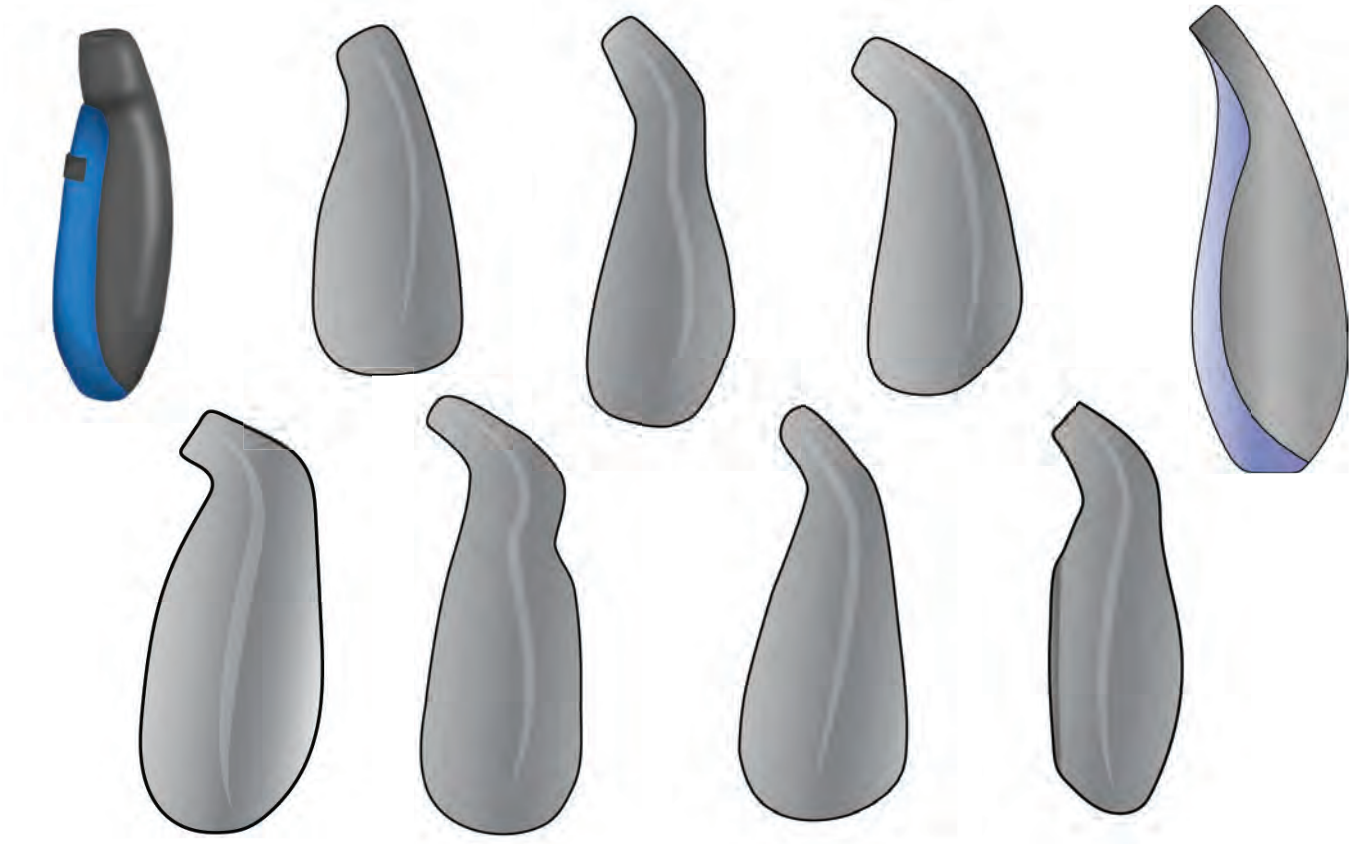
We tested the orientation of the device with potential users and used their feedback to create the first round of forms.





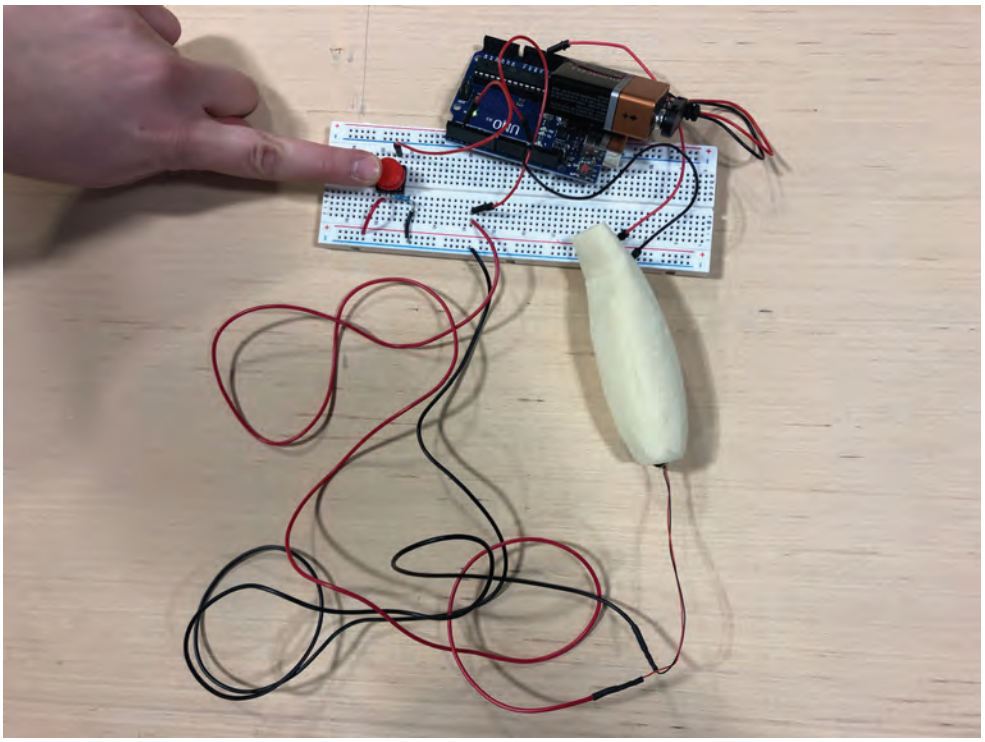


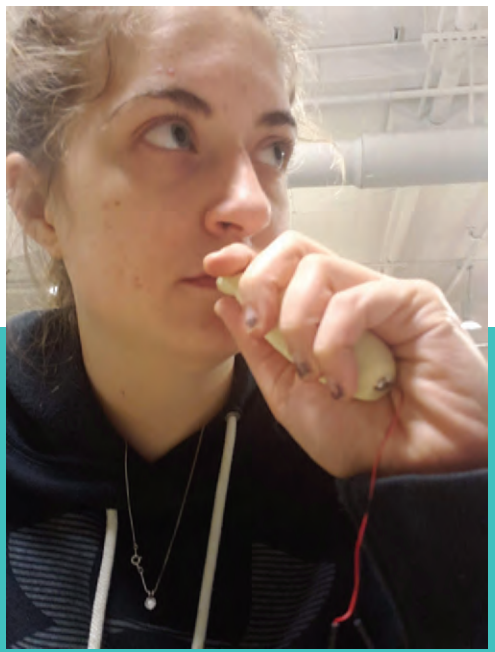


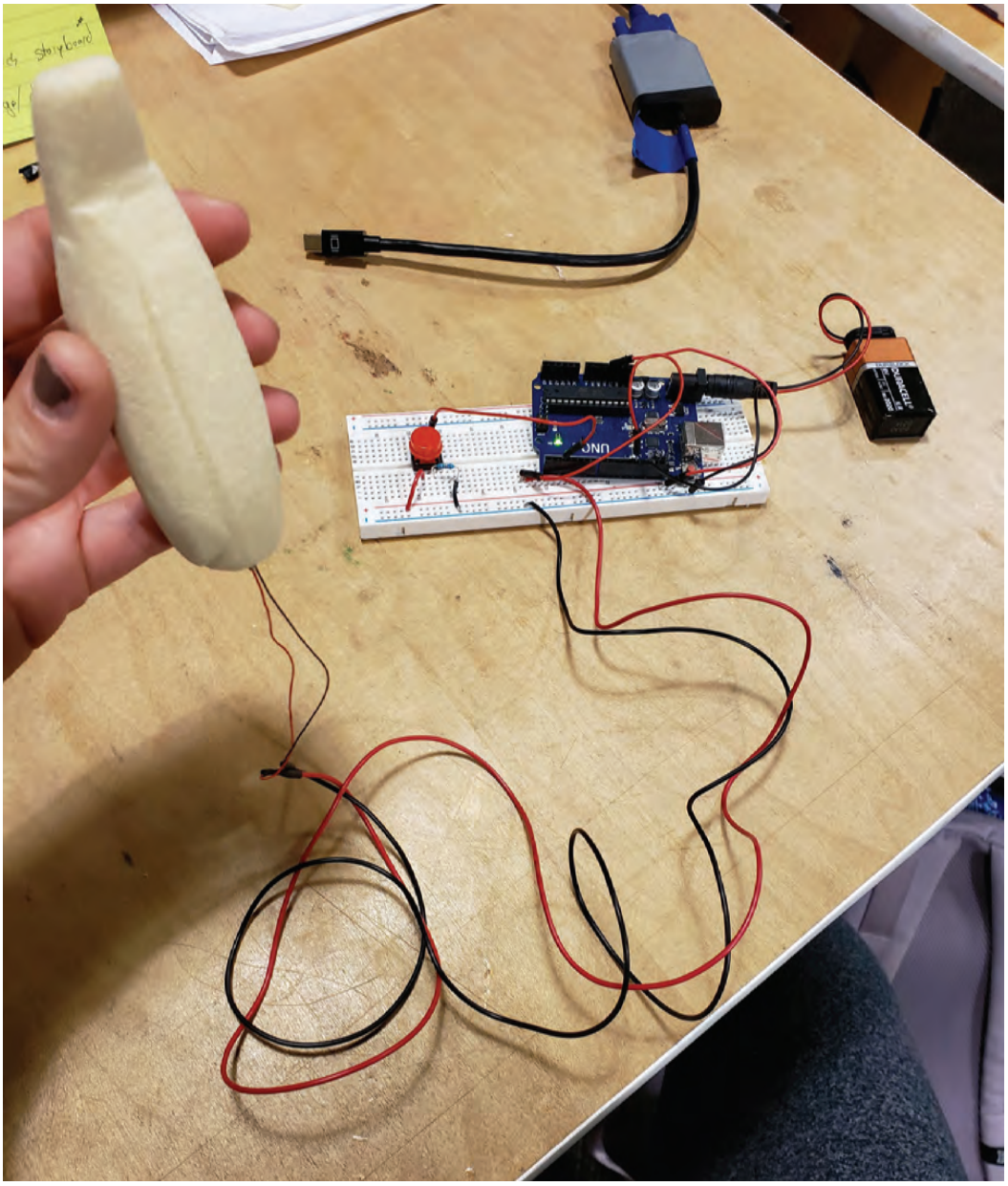


Initial **Form & Function**

The form and function of the device started developing simultaneously since they were heavily reliant on each other. This model allowed us to perform preliminary user testing.







Key Takeaways:

- Mouthpiece was angled comfortably
- Neck of device can be a comfortable thumb rest
- Vibrations are felt effectively through the model

Prototyping **Strategy**

We made a plan for the most effective method to move forward with prototypes.

Step One:

Begin by separately prototyping each of the four categories below to gain a better understanding of the components, circuitry, code, mechanics, scale, and form of each.

Haptic Feedback

Use a vibration motor to prototype vibration patterns and intensity

Breathing Detection

Find a sensor that can detect airflow to turn on an LED when the user exhales

Hyperventilation Control

Create a single valve that allows a full inhale while restricting exhale

Form

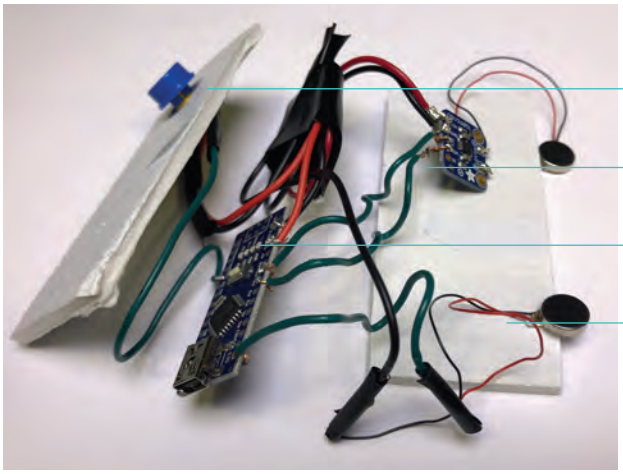
Develop a welcoming, ergonomic form that fits comfortably in most hands

Step Two:

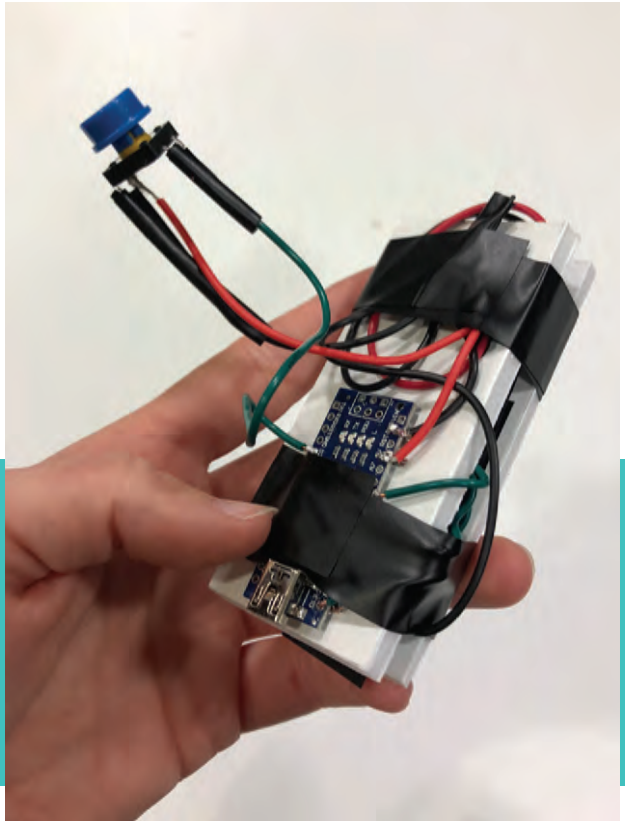
Once effective prototypes have been created in each category, begin combining them to create a fully functional prototype.

Prototyping **Vibrations**

A handheld prototype that solely focuses on vibrations would allow us to find the ideal pattern that is both soothing and communicative.

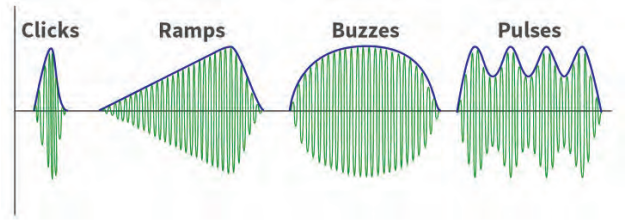


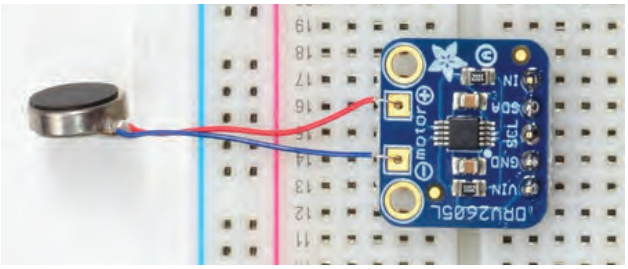
Button to Replicate Breathing Detection



Knowing that we were creating separate prototypes for vibrations and breathing detection, we had to simulate the breath. We did so by incorporating a button into the circuit. We asked users to hold the button while they were exhaling and let go when the were not. This allowed users to feel the vibration sequence while they were breathing out, similar to how they would with breathing detection.

Haptic Driver Vibration Manipulation





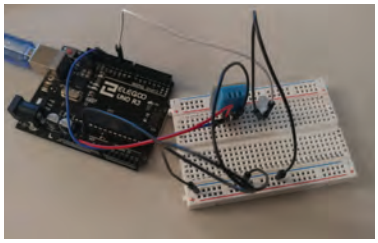
The haptic driver is what allows us to control the vibration intensity. They have numerous presets that allow you to change between vibration patterns. We could get user opinions about the most relaxing form of vibrations.

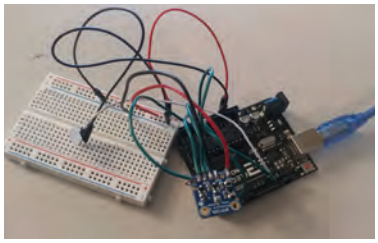
Self-Contained Handheld Device

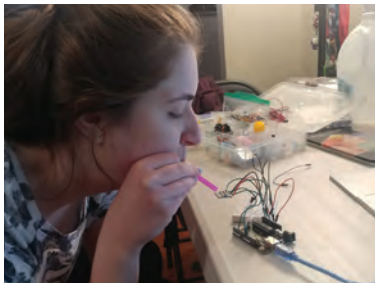
Having the tech packaged into one hand held device made testing significantly easier. By adding a straw, the user interaction was more similar to that of the final device. People could breathe into it and feel different vibration patterns.

Prototyping **Breathing Detection**

Our device needed to comprehend when a user was breathing into it. A sensor is necessary to turn the physical air flow into an electronic signal. If we could get our breathing to be detected and turn on a light, we knew that breathing would be able to control the vibrations.

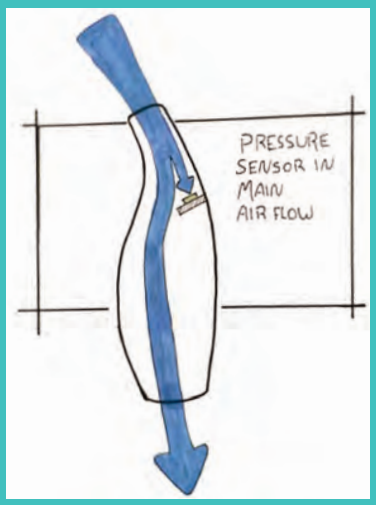


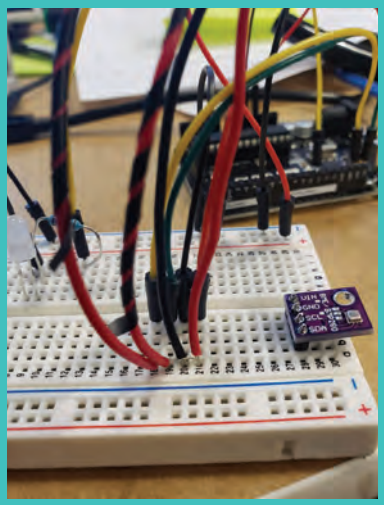




Temperature and Humidity Sensors

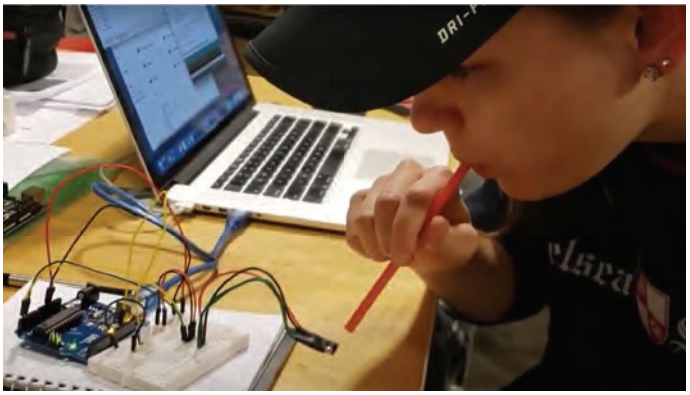
We attempted to use temperature and humidity sensors, but neither of them were able to return to their resting state quick enough. There was a lag between when we stopped breathing and when the light turned off. **To account for hyperventilation, the sensor would need to turn on and off rapidly. These sensors could not do that.**

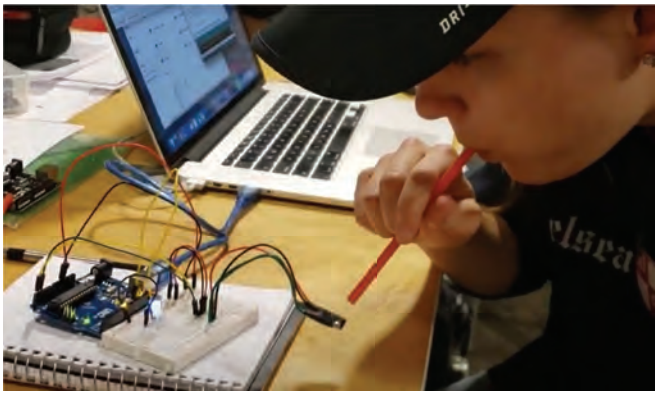


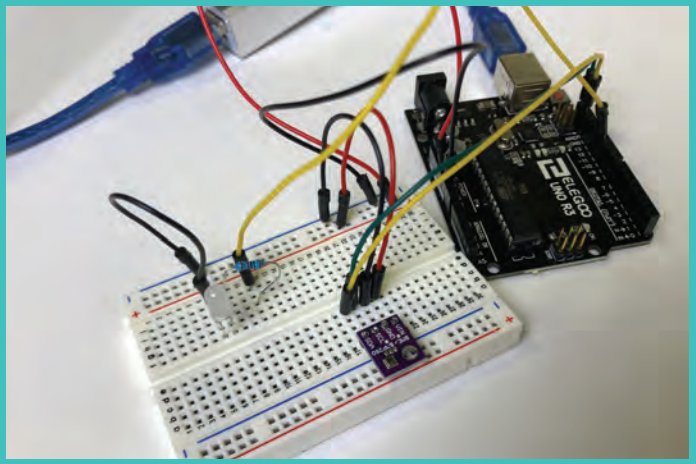


Pressure Sensors

In our code we were able to set the atmospheric pressure as a constant and tell our device that if the pressure raised above that constant, the light should be turned on. When blowing on the sensor, the light would turn on. **It is activated during exhale and unaffected by inhale.**



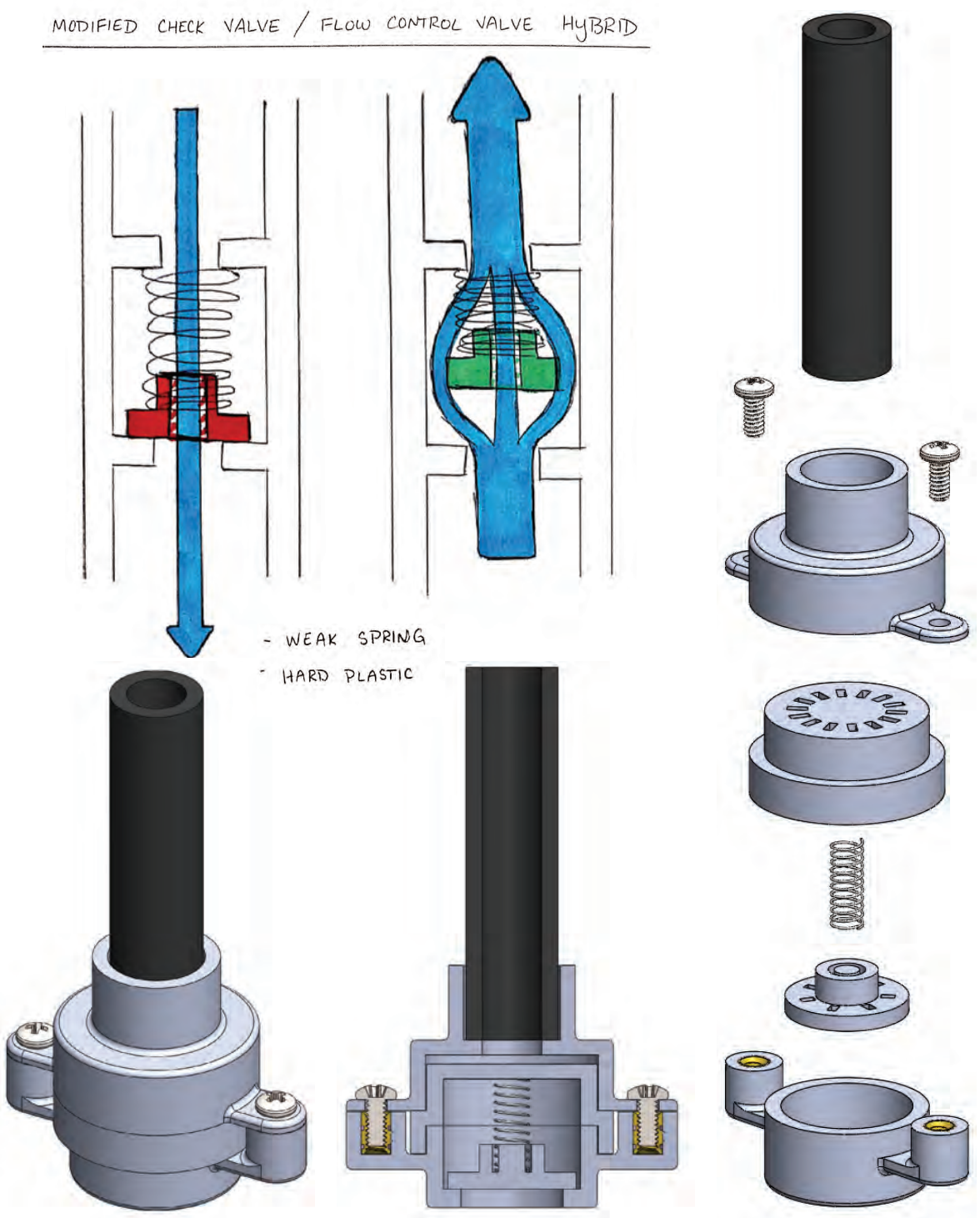


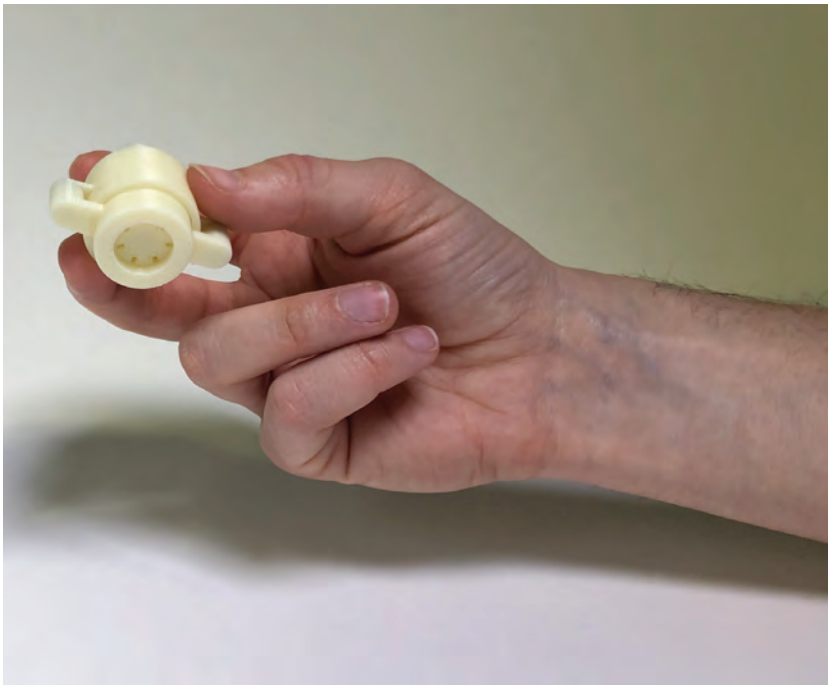


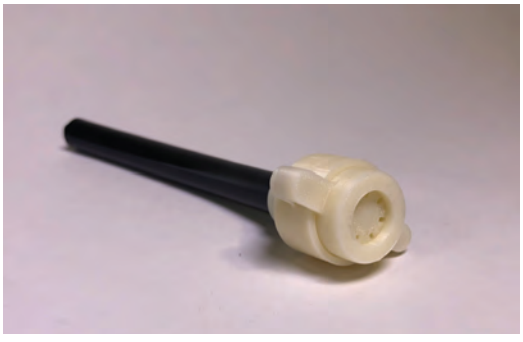
The ability to turn on a light with our breath meant we would be able control vibrations with breath as well.

Prototyping: **Valve Concept 1**

Our first attempt to create a dual-flow valve relied on a weak spring. During inhale, a disc is lifted up allowing more air to pass through than during exhale.





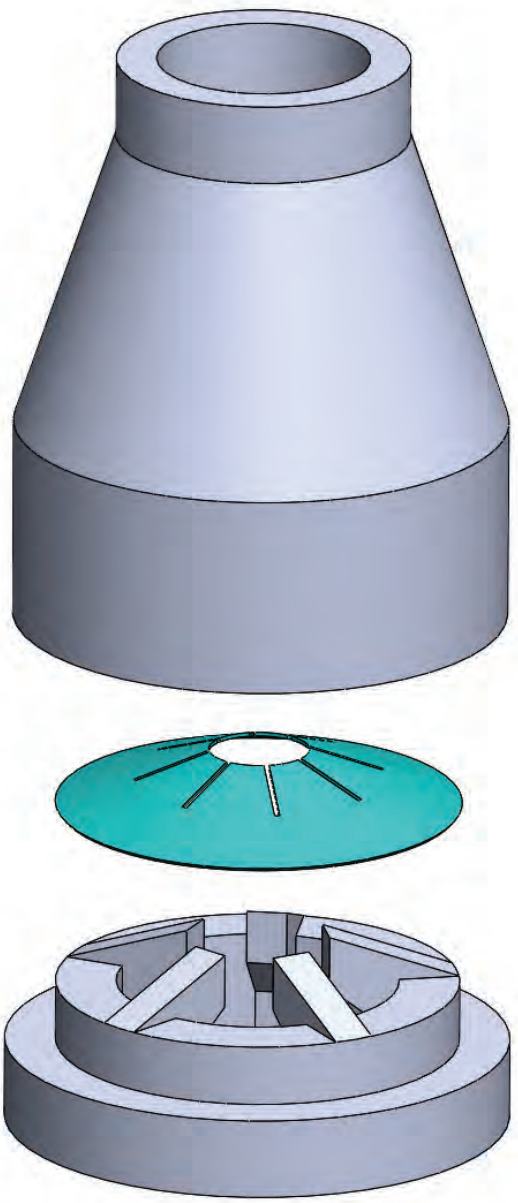


Key Takeaways:

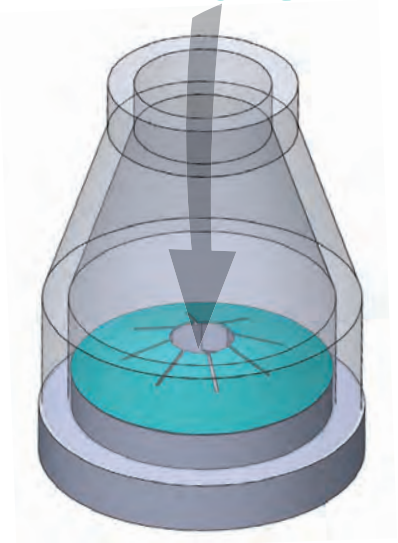
- Do not use a plastic inner disc - it creates a rattling noise
- Find a way to simplify - reduce number of parts

Prototyping: **Valve Concept 2**

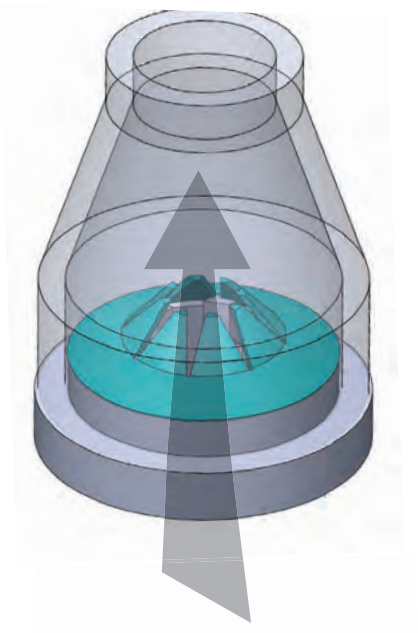
To get rid of the spring and moving disc, we switched to experimenting with silicone flaps that rest against angled plastic. When the user inhales, the flaps lift up and allow a larger airflow. When the user exhales, the flaps are pushed against the angled plastic and the airflow is restricted.

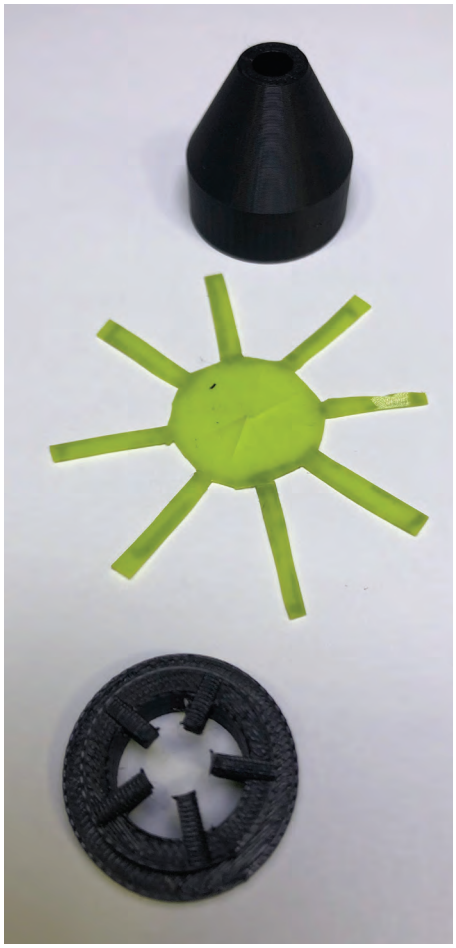


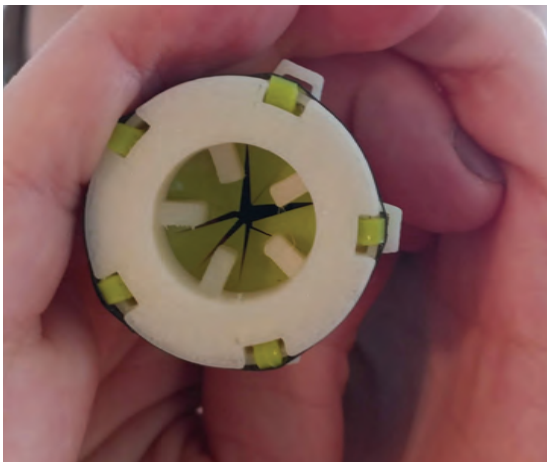
Exhale

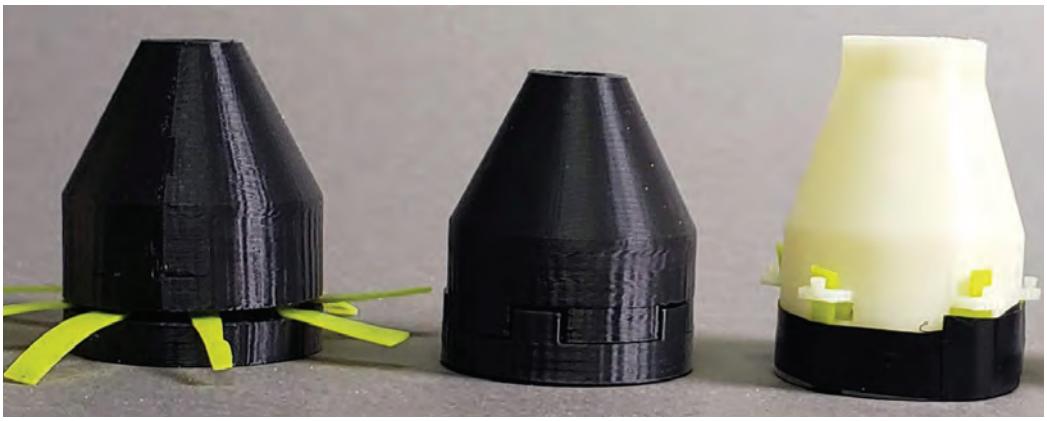


Inhale







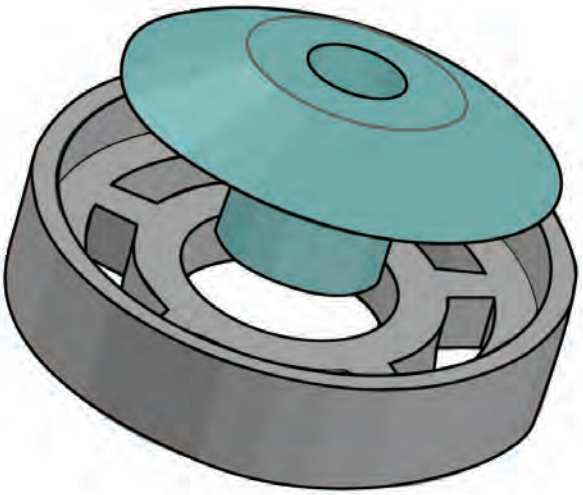


Key Takeaways:

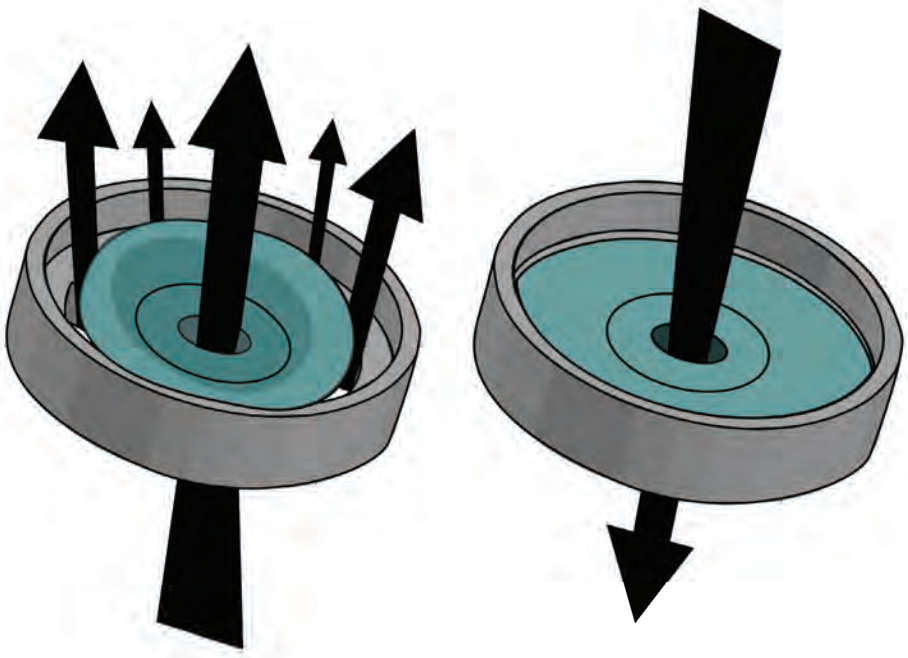
- Silicone effectively controls airflow - it can be moved easily by airflow
- Simplify silicone flap and holder - reduce size and complexity of parts

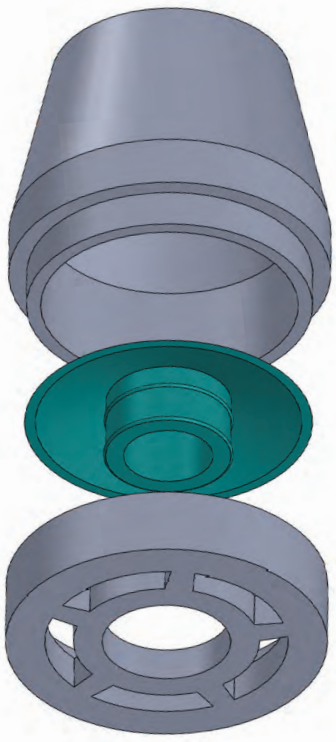
Prototyping: **Valve Concept 3**

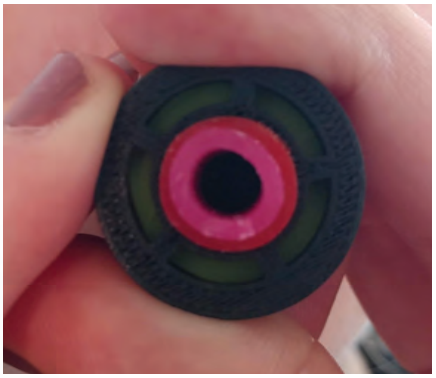
Our third valve reduced the complexity of the second valve while still incorporating silicone. The holder is a simple ring with a spoke structure. The silicone creates a weak flap that easily lifts up during inhale to reveal additional airways from the spoke structure. These additional airways are then blocked as the user exhales which forces all the air to escape through the central channel.

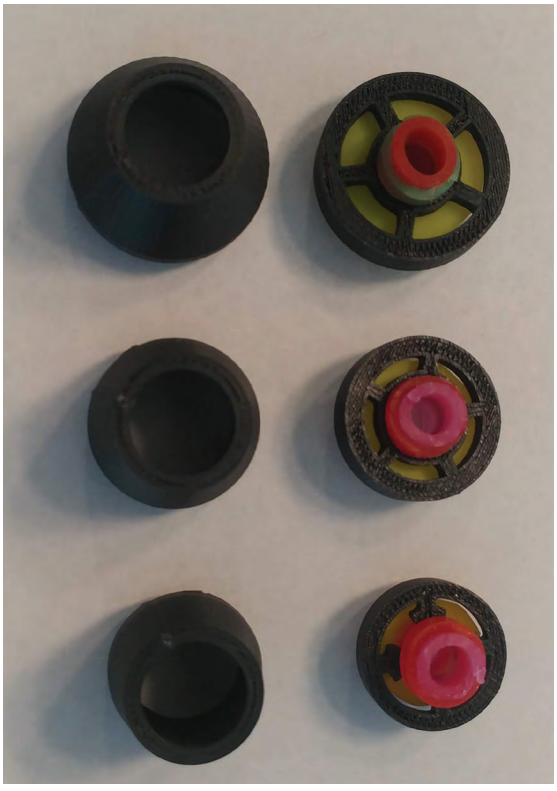


Inhale **Exhale**









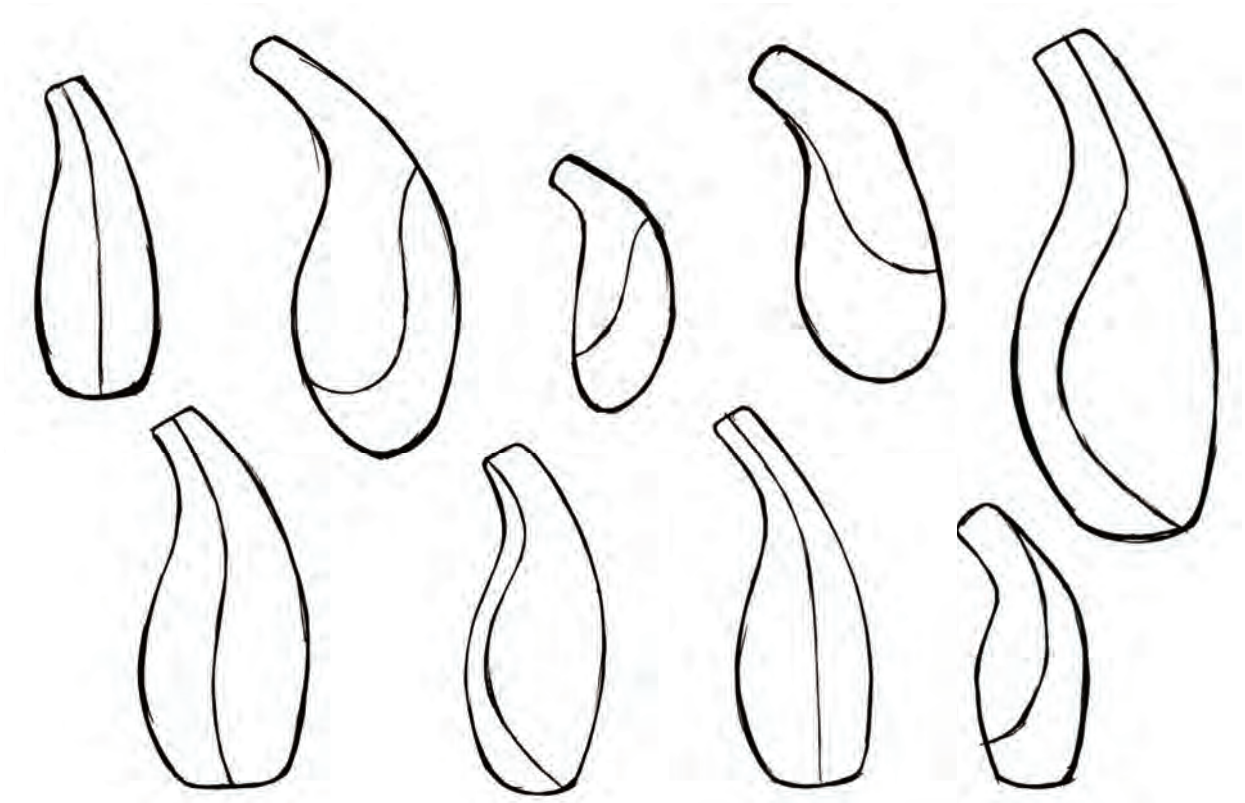
Key Takeaways:

- Simple, Compact, Effective
- This is the final valve concept

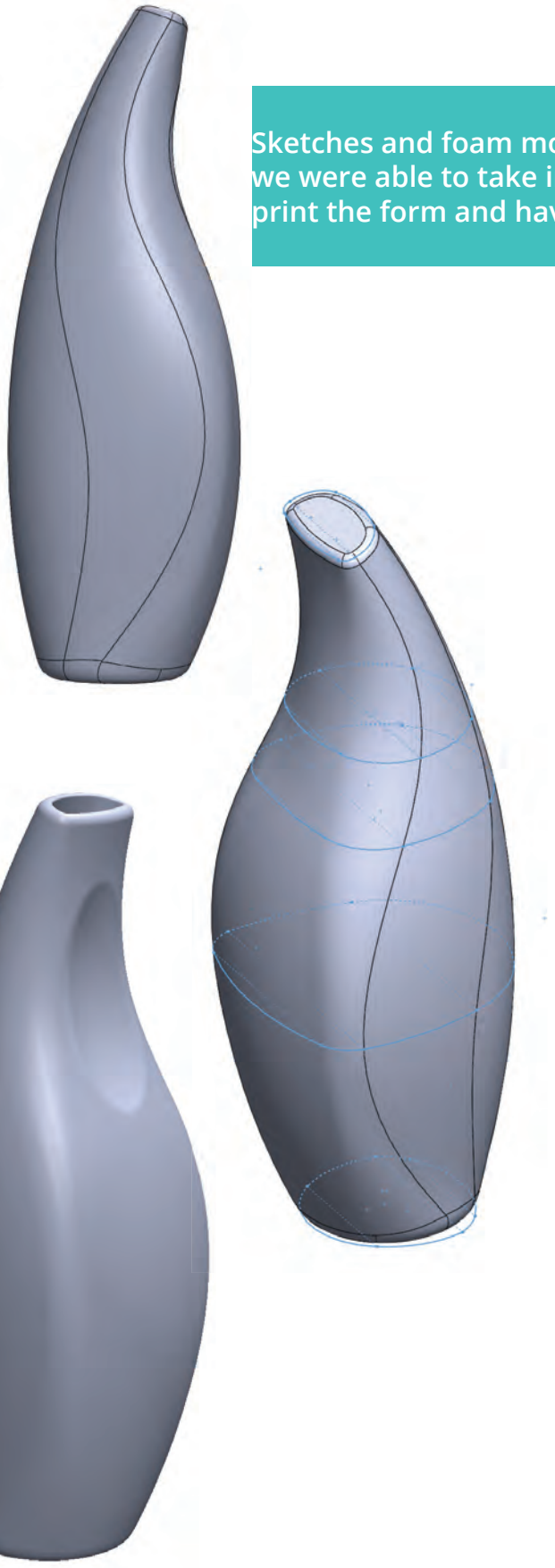
Developing **Form**

After the initial form development, we wanted to further iterate.

We wanted to keep the device compact. We were given the suggestion of looking at the company Juul and using their products as a size reference.



Sketches and foam models gave us a promising direction that we were able to take into SolidWorks. This allowed us to 3D print the form and have people hold it for ergonomic feedback.

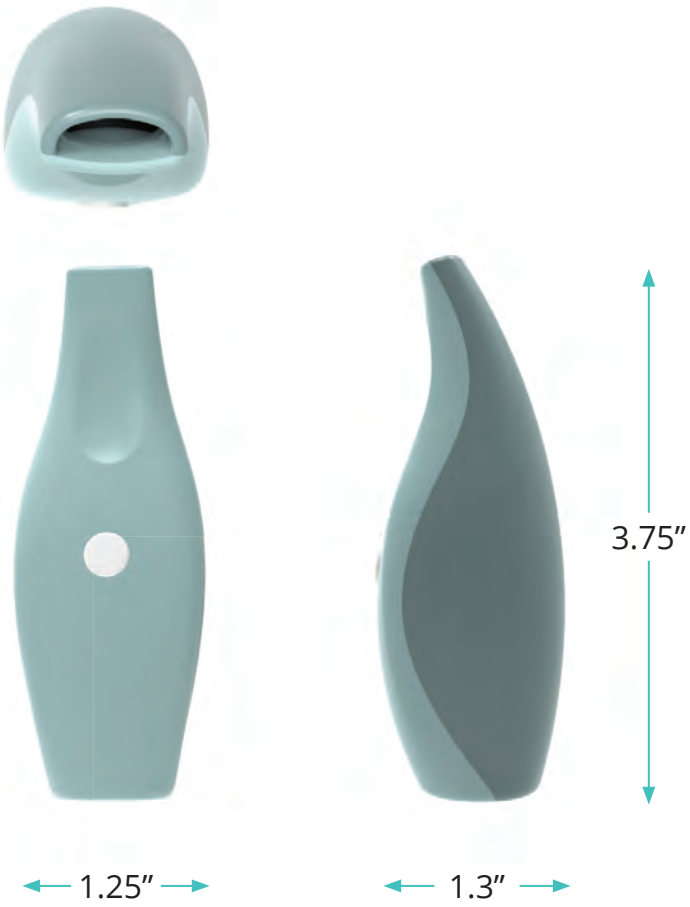


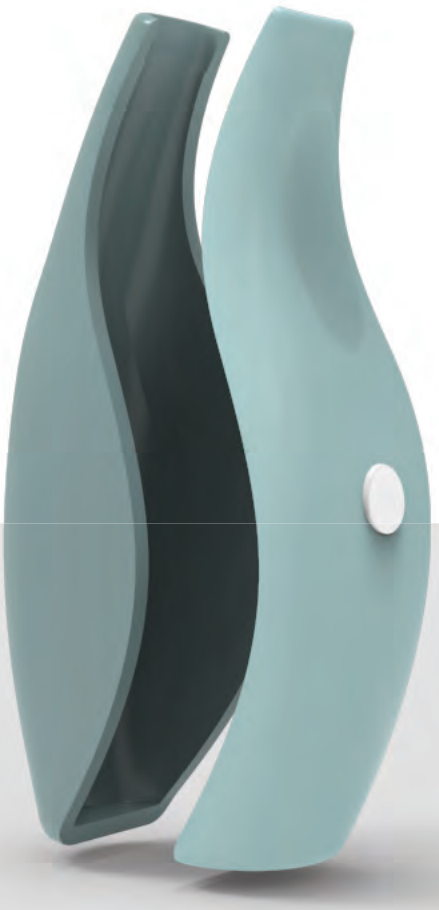
Developing **Form**

We created our first render using the new form as a means to bring more realism to the project.

The inclusion of a worry stone thumb groove provides additional tactile calming.

A single button on the front face will be used to turn the device on / off and toggle between the two modes.





This was our first attempt to explore how the device could split for manufacturing in a way that was unobtrusive to the form.

Usage: Panic Attack

We needed to clarify exactly how this product would work for ourselves and those we wished to communicate with. We created a storyboard for how the device is used during a panic attack.

PANIC ATTACK ONSET
can happen anywhere at anytime

ACCESS DEVICE
remove from backpack

BREATHE OUT
slow and restricted exhale
calms the nervous system

HAPTIC FEEDBACK
vibrations during exhale create
a methodical focus activity

3

TURN ON
one button press

4

BREATHE IN
inhale through device without restriction during hyperventilation

7

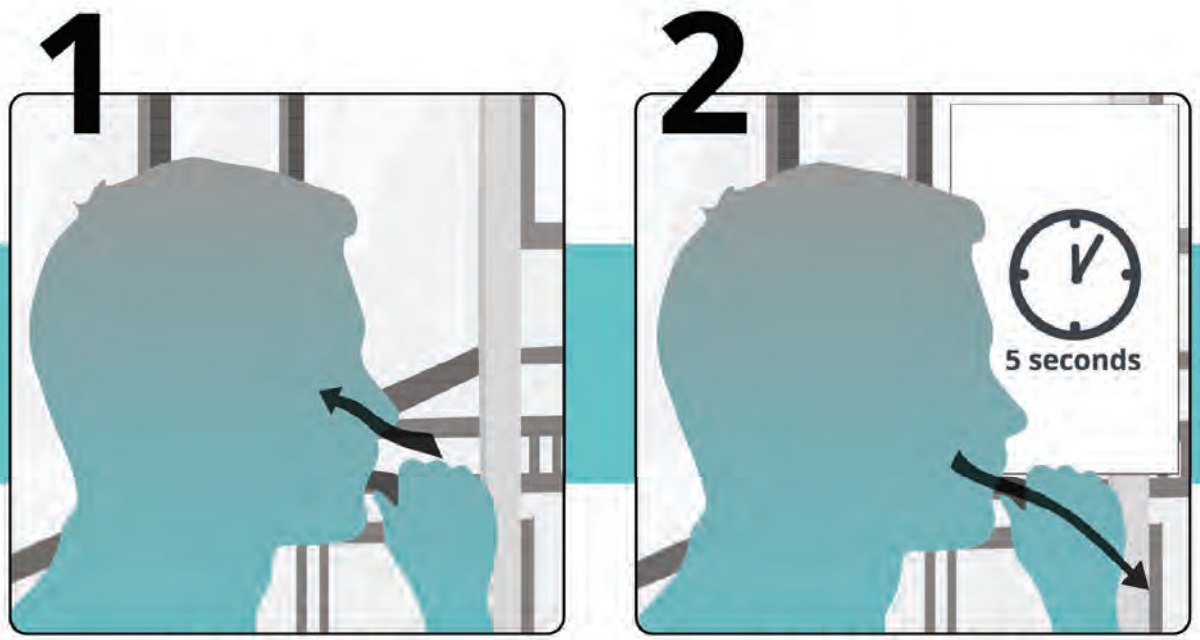
BREATHE CORRECTLY
as you calm, breathe in through nose and out through mouth

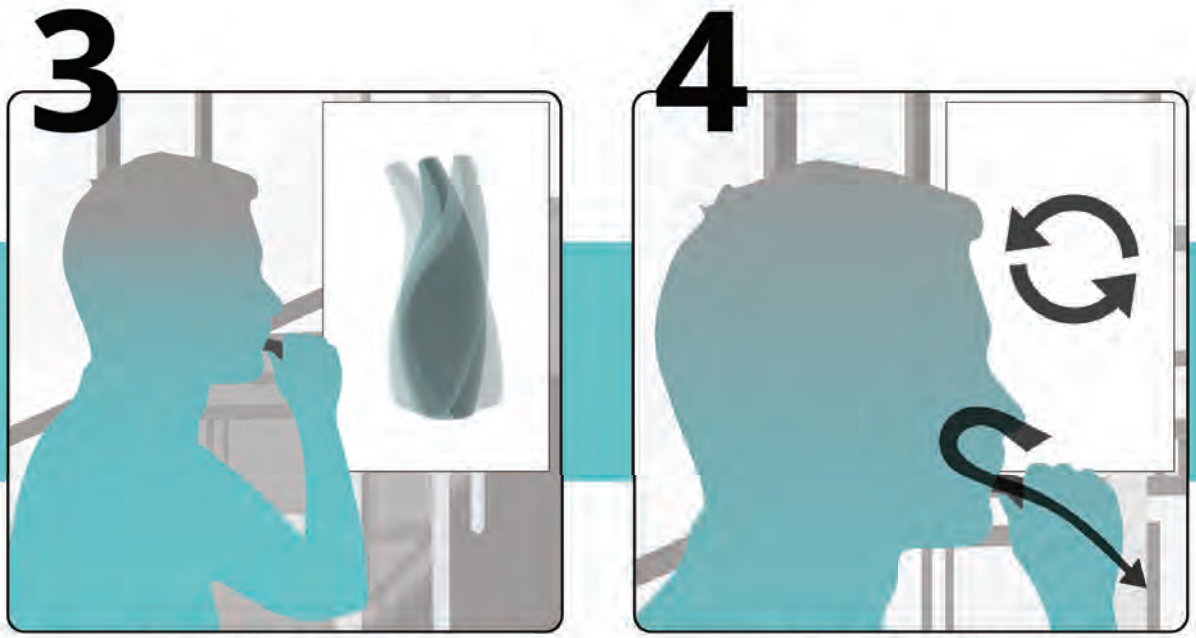
8

CONTINUE YOUR DAY
put away device once breathing normalizes

Usage: **Mindfulness**

We created a second storyboard that showed how the device would be used for mindfulness. **The mindfulness mode uses a timed vibration cycle that the user tries to match their breathing to.** It does not use the breathing detection that is used during panic attacks.





FEEL VIBRATION
indicates exhale is complete

REPEAT CYCLE
continue as long as desired

Prototyping **Status**

Each prototype was a successful proof of concept at this point.

Haptic Feedback
Vibration Motor

Breathing Detection
Pressure Sensor

Next step:
combine the prototypes for testing and validation

Hyperventilation Control
Dual Flow Control Valve

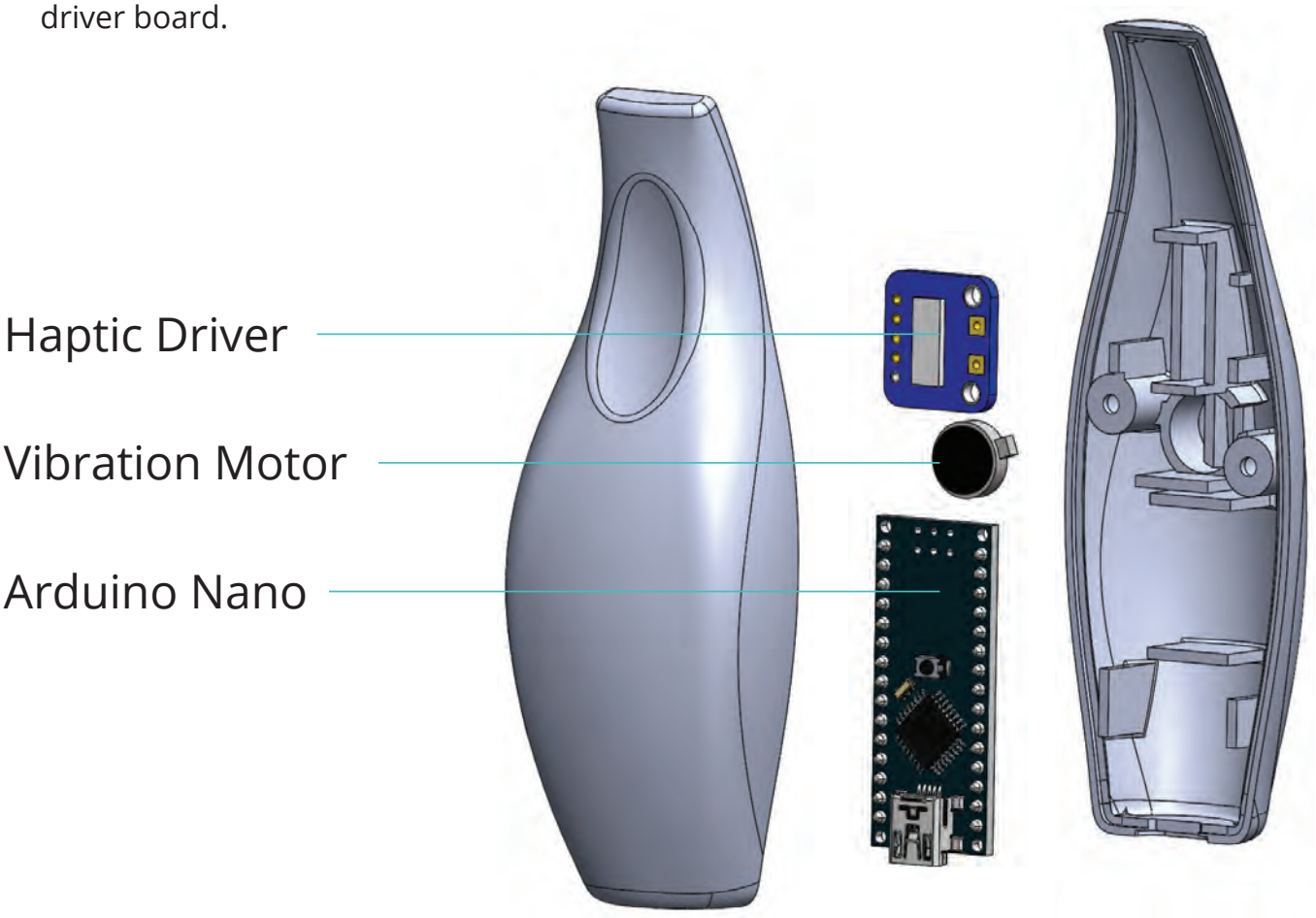
Form
3D Print

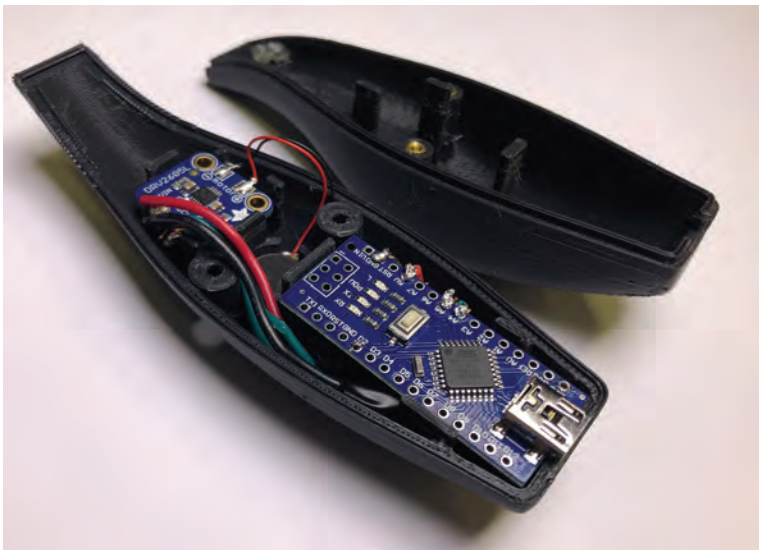
Other considerations moving forward:

- Cleaning
- Manufacturing
- Cap
- User Interactions

Refined **Prototype 1**

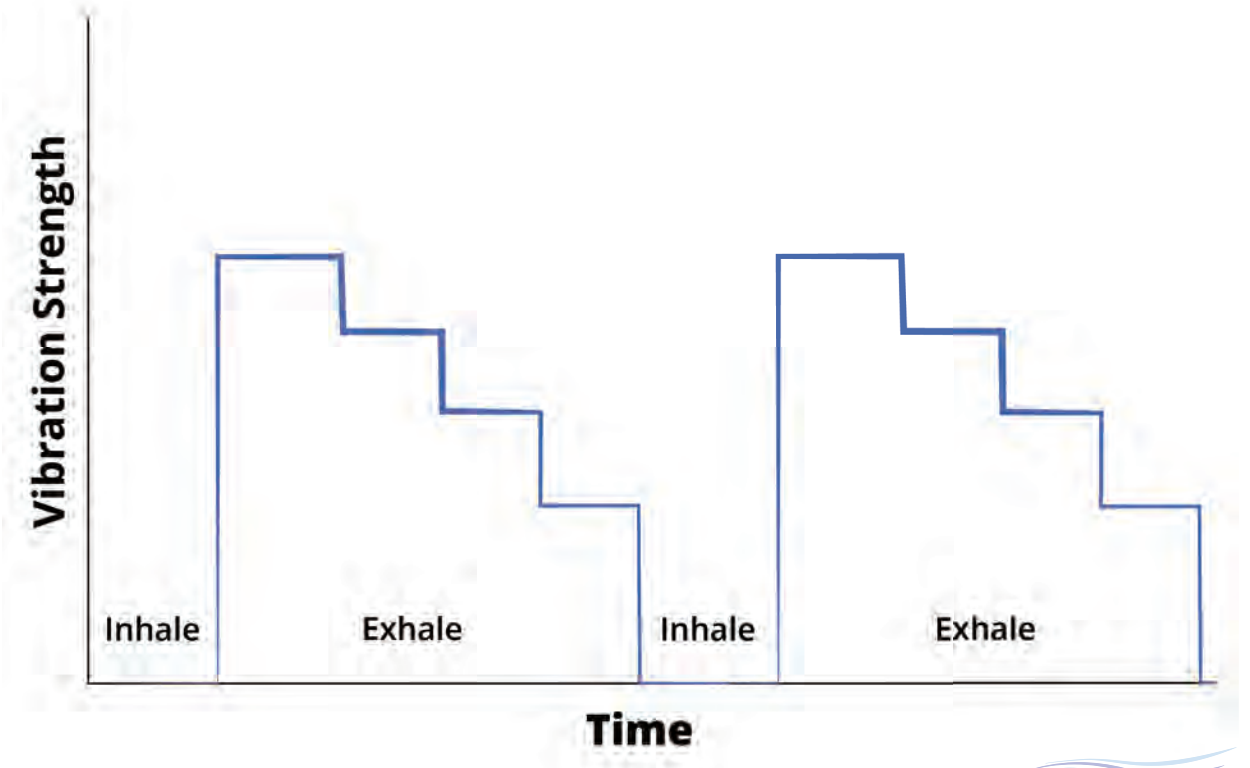
We created our first refined prototype to combine vibrations with a more defined form. We were able to achieve this with 3D printed casework that split the form in half to hold an Arduino Nano, vibration motor, and haptic driver board.





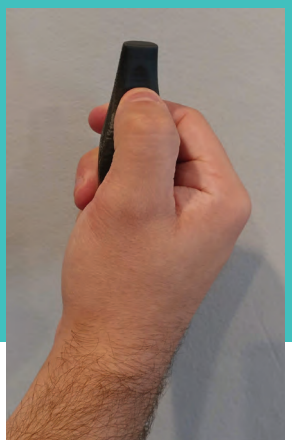
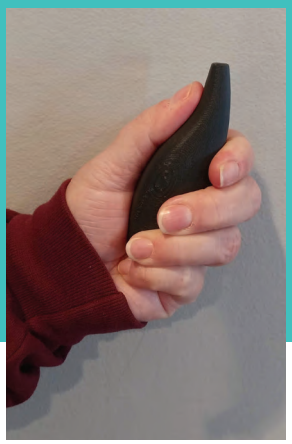
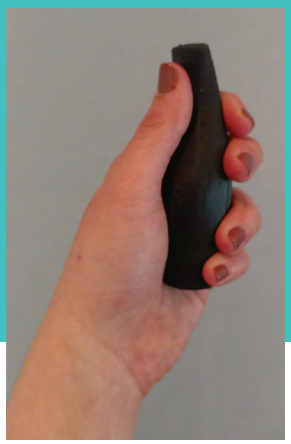
The electronics were wired, soldered, and assembled into the back half of the casework. Heat set threaded inserts were pressed into the front half, and the device was assembled. An external battery was used to power the prototype. The battery was plugged into the Arduino Nano through the bottom of the casework.

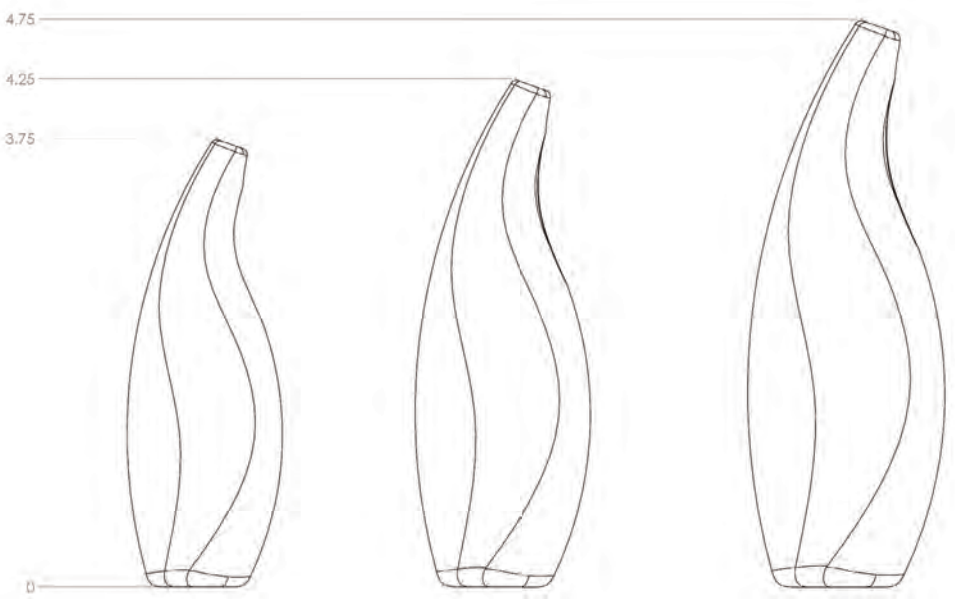
Vibration Pattern

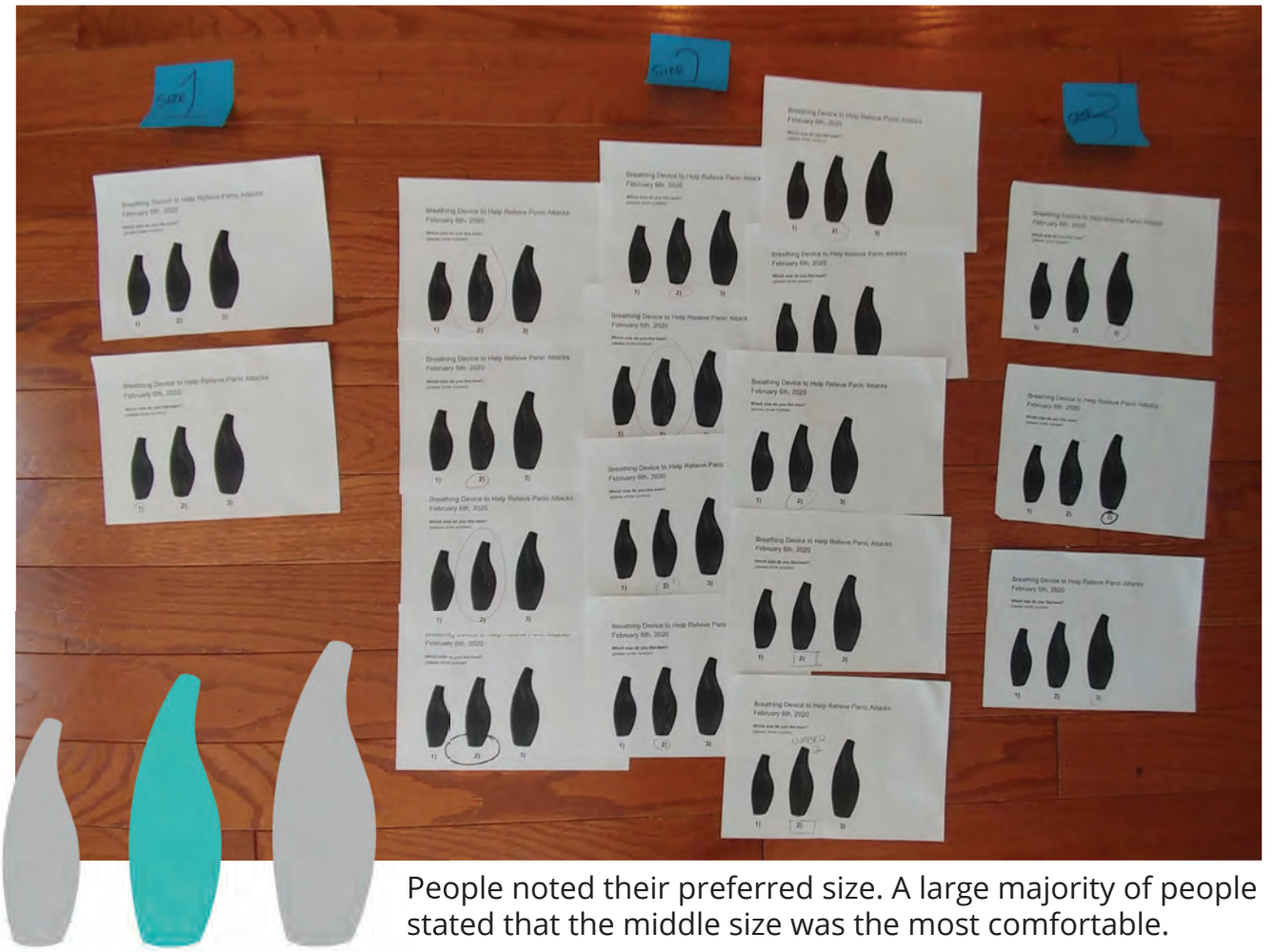


Prototyping **Size**

We had the overall form finalized but there was uncertainty around the exact dimensions. We created 3 size options and asked many people with varying hand sizes to hold them.



People noted their preferred size. A large majority of people stated that the middle size was the most comfortable.

NAMI Testing

We brought our prototypes and visual supplements to the National Alliance on Mental Illness for feedback.

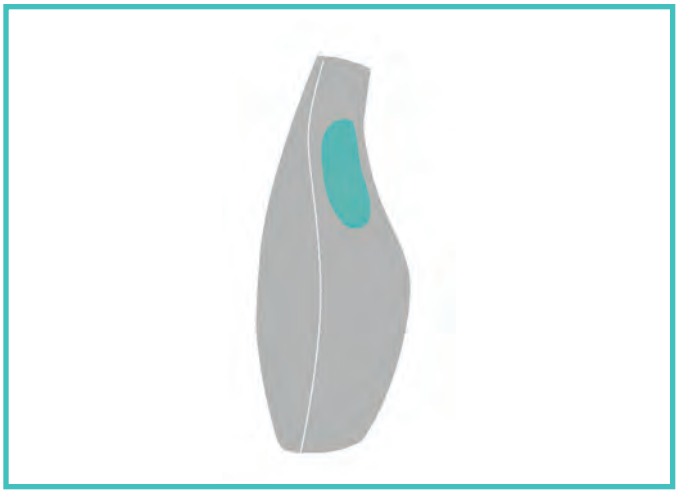
Testing Goals:

- Vibration Pattern Feedback
- Opinions Towards Two Modes
- Comfort/Worry Stone Observations

While sitting in on a support group, we were unable to take pictures or notes for **confidentiality reasons** but we could interact with and observe users.

Vibrations were validated as being a relaxing form of feedback. The vibrations at 50% intensity were described as feeling "soft"

This was a significant improvement over our previous models



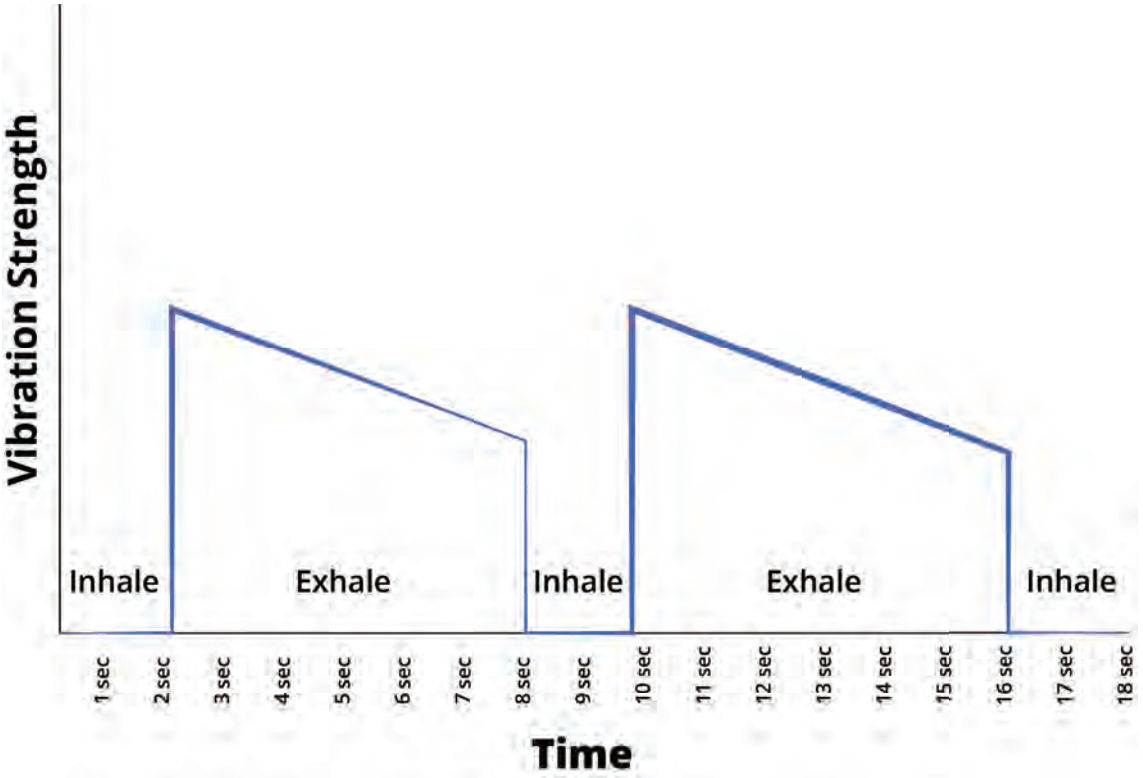
The worry stone thumb groove was well liked and received all positive feedback

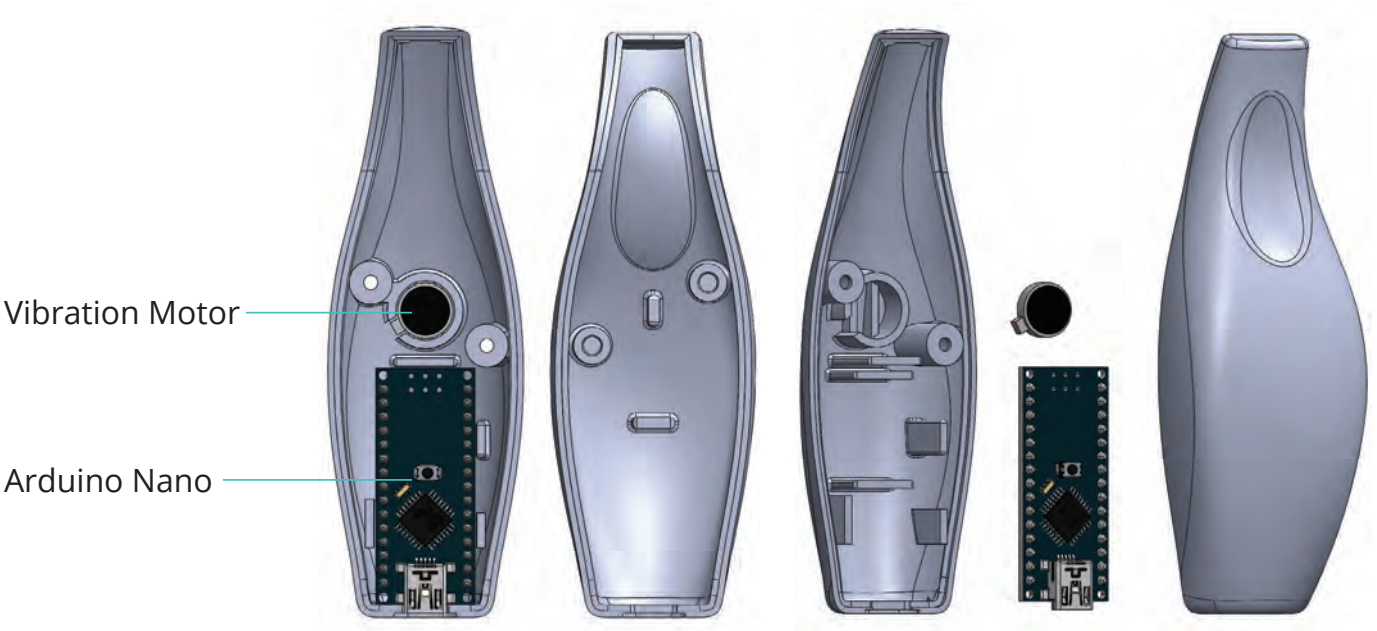
The pulsing vibration pattern we used was confusing. A single, smooth, fading vibration would be more effective

Two modes are needed. It is beneficial to have vibrations controlled by breathing, but it would also be beneficial to be able to keep the device in your hand and feel vibrations

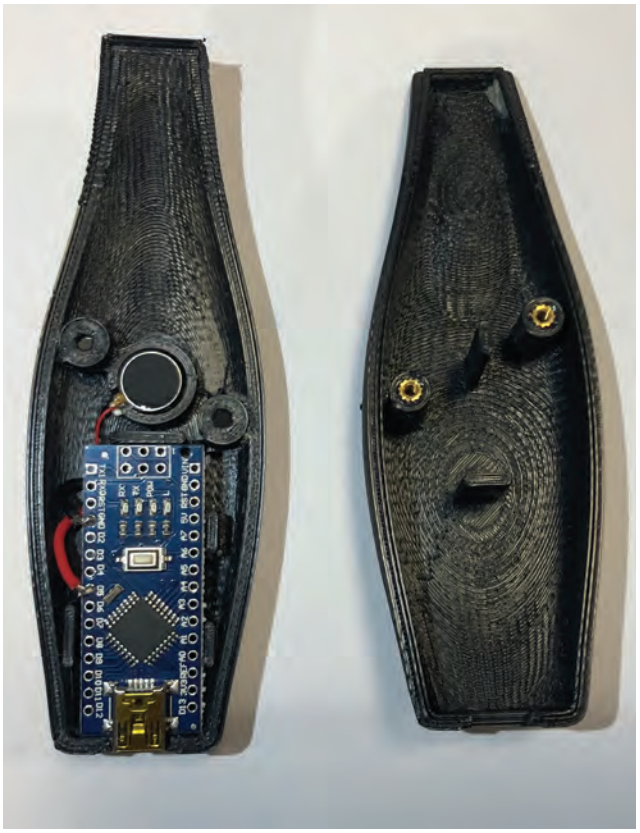
Refined **Prototype 2**

After testing our initial prototype with NAMI, we were able to create a second prototype that used a smooth, fading vibration.





We were able to simplify this prototype by eliminating the haptic driver board. We realized that we did not need pre-programmed effects to create a smooth fade. Using a circuit and code similar to how an LED light is able to fade on and off, we created a smooth, fading vibration on a timed cycle.

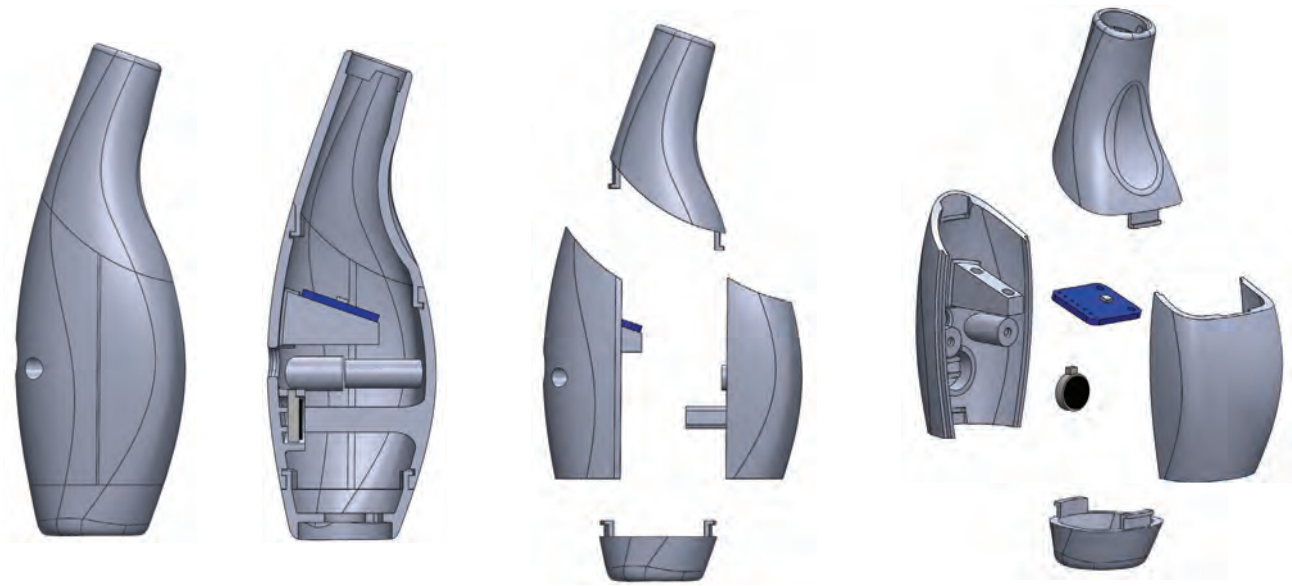


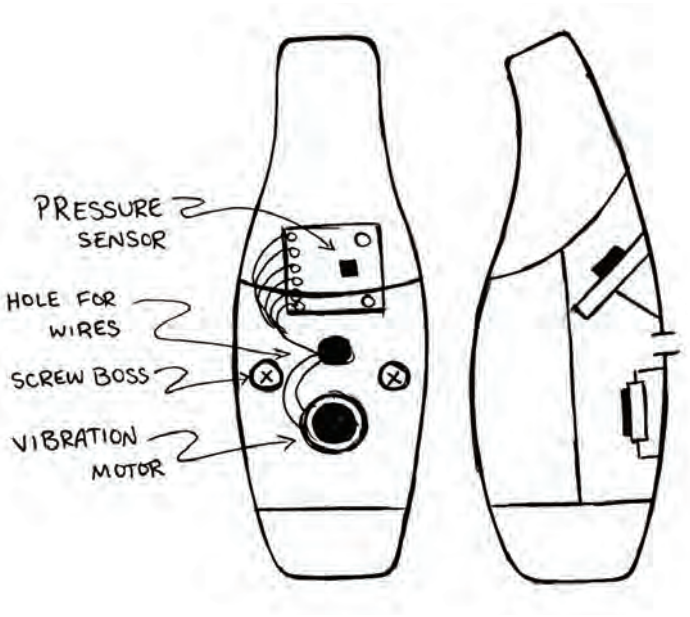
Key Takeaways:

- Ideal for mindfulness
- Vibrations are clear
- Need to prototype breathing detection

Refined **Prototype 3**

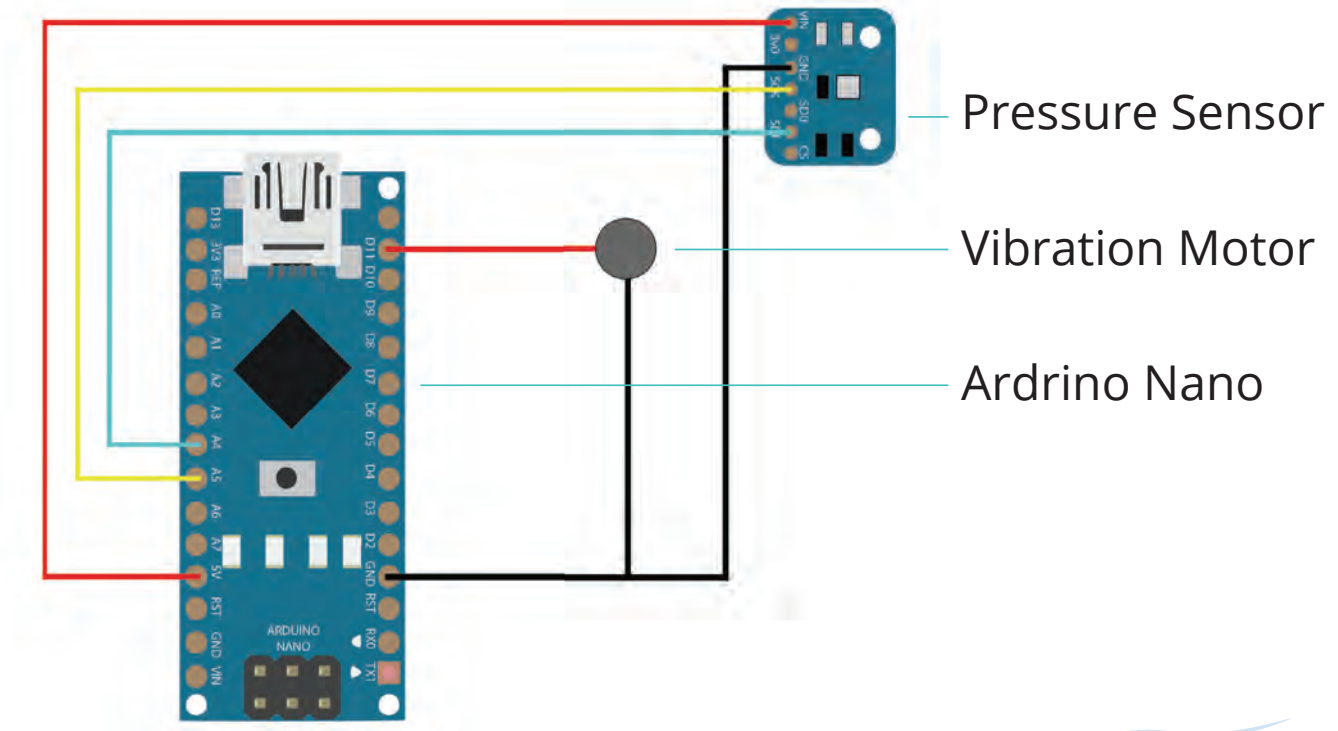
Prototype three focused on implementing the breathing detection. Having a user breathe through the device would activate vibrations on their exhale. This required improvements in our code and wiring.





Wiring - Externalizing the Arduino

We realized that the Arduino should be removed from the inside of the device. In production, the circuit board would take up a fraction of the space so keeping the Arduino uses up an unnecessary proportion of our interior.

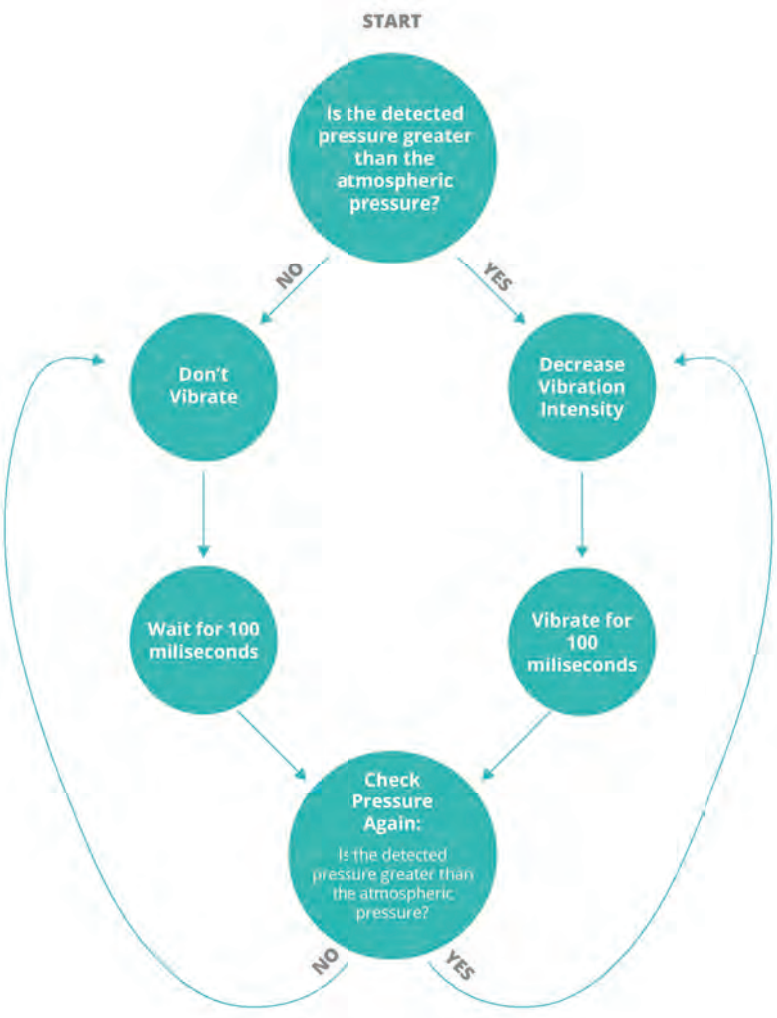


Refined **Prototype 3**

To make a fully testable prototype, we had to write code that had air pressure fluctuations turn on and off the vibrations for the panic attack mode.

Logic Behind Code - Panic Mode

Our code needed to allow users to feel the vibrations as they exhaled. We were able to do so by writing the code with the following logic:



working_proto | Arduino 1.8.10

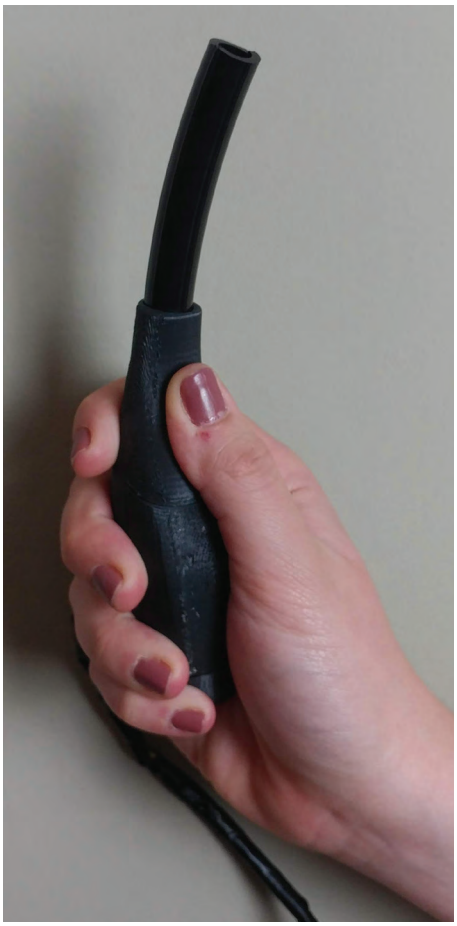
File Edit Sketch Tools Help

working_proto §

```
int vibrationPin = 11; //sets vibration pin
//check pressure threshold for breathing calibration
//check delayTime for time between readings

int32_t pressureValue = 100345;

////////////////////////////////////////////////////////////////////////////////

//libraries and things to include
#include <Adafruit_Sensor.h>
#include <Adafruit_BME280.h>
Adafruit_BME280 bme; // I2C
unsigned long delayTime;


void setup() {

pinMode (vibrationPin, OUTPUT);
Serial.begin(9600);

    while(!Serial);    // while serial is starting up
    Serial.println(F("BME280 STARTUP"));

void loop() {

//print pressure value
Serial.print("Pressure = ");
Serial.println(bme.readPressure());
      delay(delayTime);

//if pressure > threshold (breath detected), start vibrations
//CAN CHANGE THRESHOLD NUMBER
if ((bme.readPressure()) > pressureValue ) {
  for (int fadeValue = 150 ; fadeValue >= 140; fadeValue -= 2) {
    // sets the value (range from 0 to 128)
    //255 is 100% power
    analogWrite(vibrationPin, fadeValue);
    // wait for 100 milliseconds to see fade effect
    delay(100);
    //print pressure value
    Serial.print("Pressure = ");
    Serial.println(bme.readPressure());
}
}
else {
  digitalWrite (vibrationPin, LOW);
  }

if ((bme.readPressure()) > pressureValue ) {
  for (int fadeValue = 139 ; fadeValue >= 130; fadeValue -= 2) {
    // sets the value (range from 0 to 128)
    //255 is 100% power
    analogWrite(vibrationPin, fadeValue);
    // wait for 100 milliseconds to see fade effect
    delay(100);
    //print pressure value
    Serial.print("Pressure = ");
    Serial.println(bme.readPressure());
}
}
```

Testing

Replaceable Mouthpiece



We tested both Panic Attack Mode and Mindfulness Mode. At this point, we were doubting the necessity of incorporating both. Users responded strongly and reinforced that they were helpful in different ways. It was overwhelmingly positive towards having both modes. Testing also allowed us to tweak the sensitivity of vibrations so that they were more responsive.

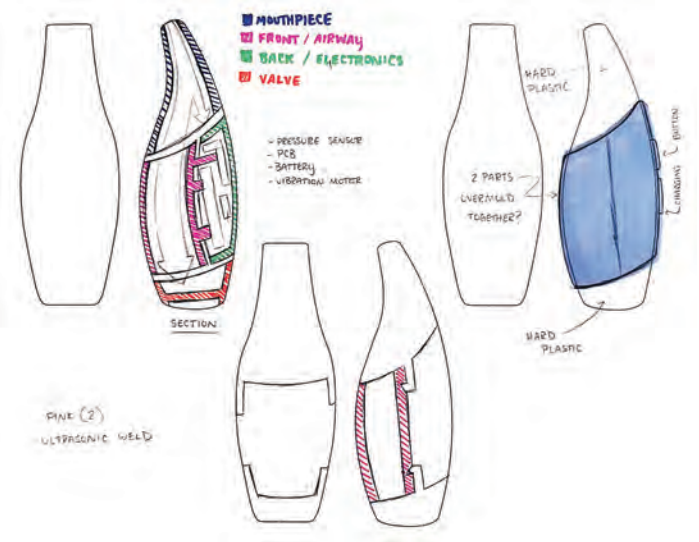
Testing confirmed that we absolutely need both modes.

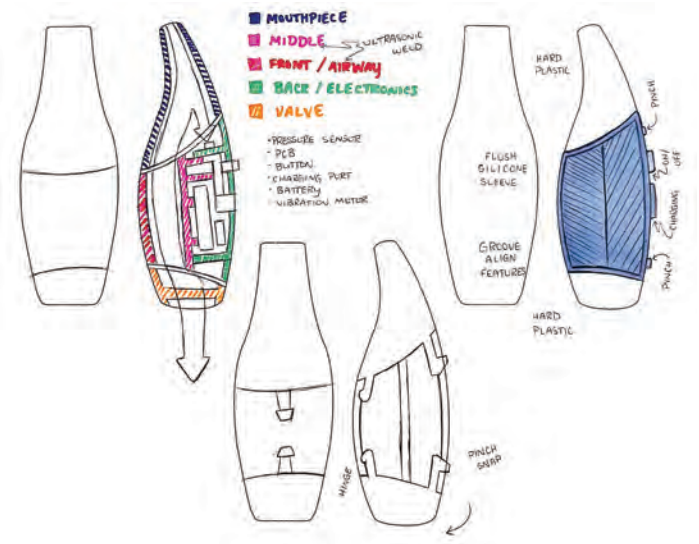
Manufacture for **Cleaning**

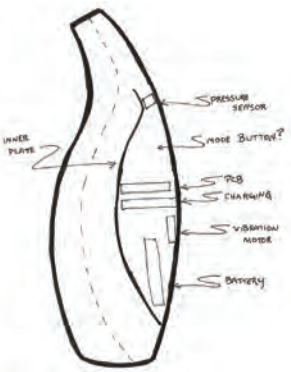
The device will be in contact with the mouth and possible contaminants during transportation. This requires manufacturing that allows frequent component separation as well as electronic protection.

Main Considerations

Removable mouthpiece - easy and frequent cleaning
House components together - can be removed for washing process
Multiple material usage - visually communicate what gets washed







Mouthpiece and worry stone can be separated and washed

Mid-section will house all electronics in the back half and shield them from airflow

Valve can be separated and washed

Bottom can be separated and washed

Silicone Sleeve

- Hides parting lines and screw bosses
- Prevents disassembly
- Covers charging port
- Can be wiped clean

Iterating **Caps**

Since the device needs to be transported in bags and purses, the mouthpiece needed to be protected.

Initial Concept

At first, we required that the mouthpiece and valve were both covered.

Shortcomings:

- Too complicated to remove easily
- Users may not keep it

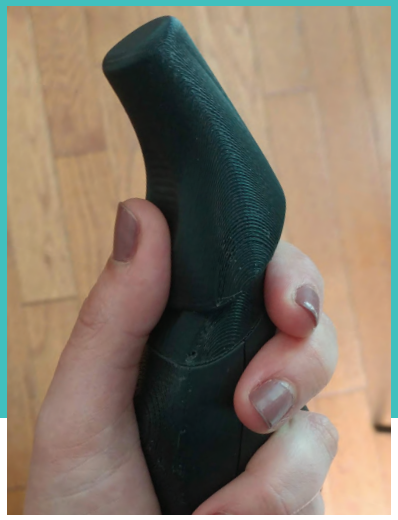
We realized that it was not critical for the valve to be covered. The regular cleaning process would keep it clean for usage.

Second Concept

- Too small and easy to lose
- Does not match device's aesthetic
- Cap could accidentally be removed by worry stone usage

Final Cap

- Incorporating the worry stone allows for usage that keeps the mouthpiece covered
- Mimicking the mouthpiece form creates a visual continuity
- Worry stone can be used as a grip to remove the cap



Iterating **User Interaction**

Since our device has two modes, we had to find a way for users to toggle easily between the modes.

Toggle Between Modes

Press Once: **Panic Attack Mode**
Press Twice: **Mindfulness Mode**
Press Three Times: **Turn Off**

Switch Between Modes

Panic Attack Mode:
- Easiest to switch to
- Furthest from off state

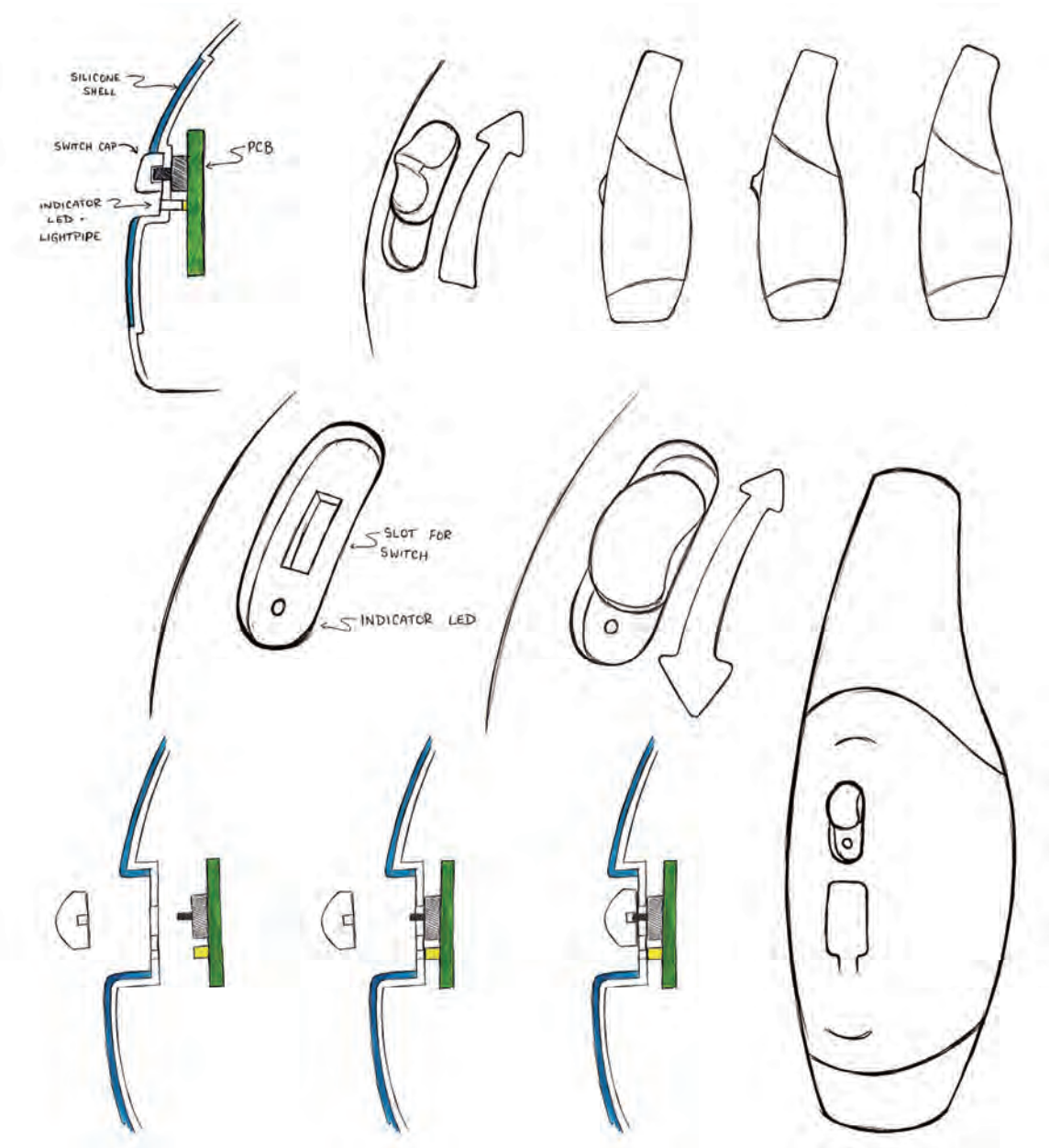
Mindfulness Mode:
- In middle position
- Calm state usage

Button Takeaways:

- Toggle button leads to stress if you pass desired mode
- Mode selection needs more control

Original Switch Takeaways:

- Switch has simpler interaction
- Original does not look intentional
- Aesthetic improvements needed



By incorporating an LED and revisiting the form, the switch would better suit the device.

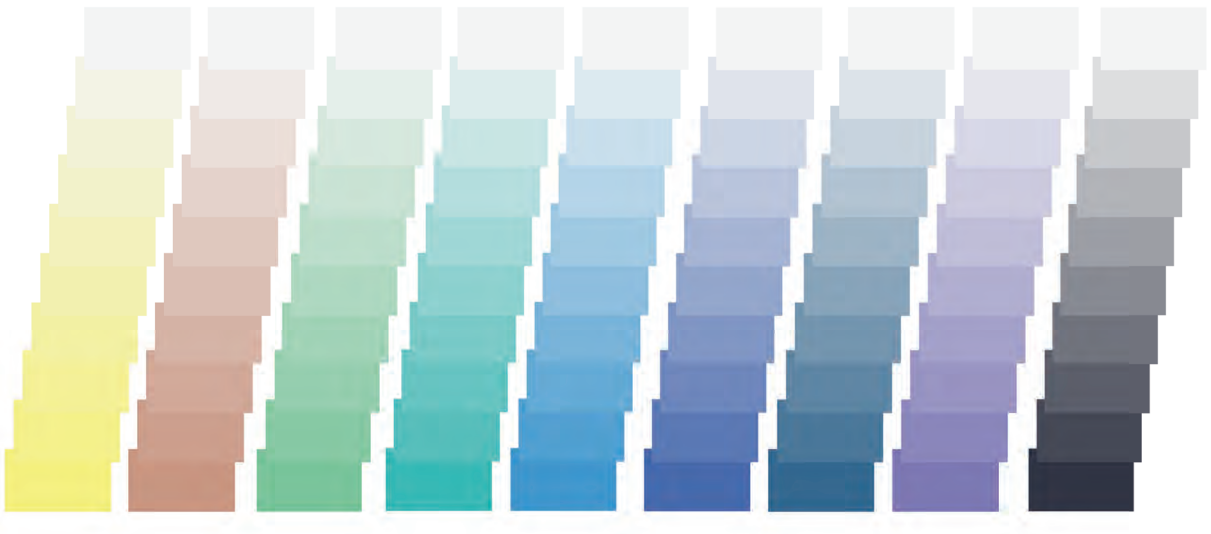
Researching **Color**

We wanted to make sure the colors of the device conveyed a calming feeling. To do so, we researched colors and found what could assist in the calming.

Colors Studied to Promote Calmness:

Blues	Light Pinks
Light Greens	Yellows
Teals	White
Lavenders	LIght Greys

"The lighter the color, the more it is associated with calmness and relaxation."
-IFL Science



A global survey conducted by University of Sussex (UK) psychologists revealed that navy blue, teal-like turquoise, and soft pastel pink/ purple are the most relaxing colors
-IFL Science

Peaceful and calm, blue paint colors can calm your mind, lower your blood pressure, and reduce anxiety, and even slow your heart rate.
-decorist

Selected Color Swatches

The silicone sleeves were perfect to implement the calming colors. The plastic pieces could all be manufactured in a neutral grey and then paired with a colored sleeve.

Final Design

A portable and discreet assistive breathing device to reduce the severity, duration, and frequency of panic attacks.

Personal Calming Device

Portable & Discreet

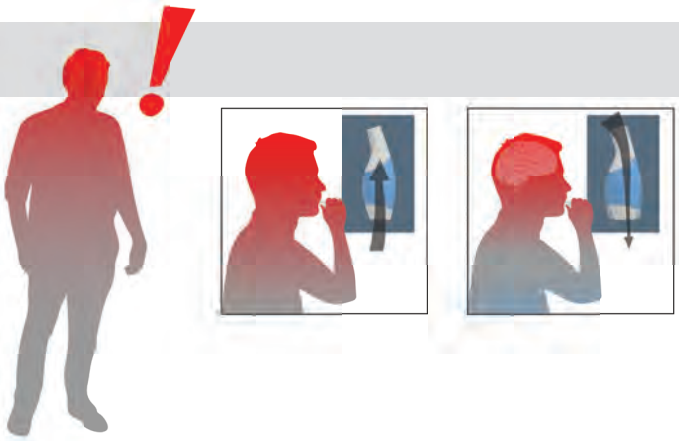
Medical Support

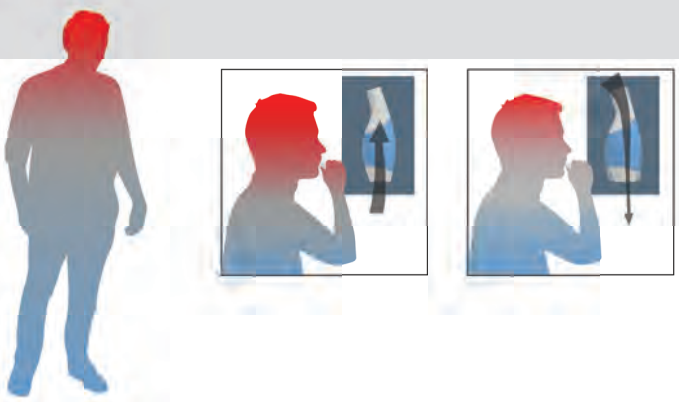
Drug Free

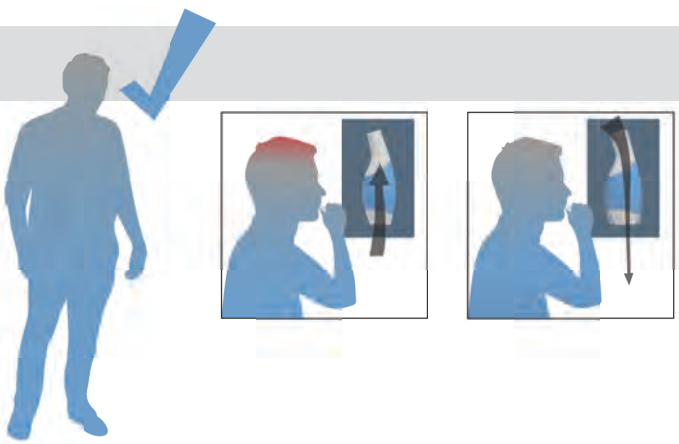
Para is a handheld focus object designed with the support of medical professionals to help create a natural, drug free, calming response through breathing. This response helps to alleviate the symptoms of a panic attack and assist with mindfulness exercises.

How to Use **Para**

When experiencing a panic attack, Para provides a simple focus object and activity to help users control their breathing and feel grounded.







Breathe

When you feel a panic attack coming on, start breathing through the device. Take a full breath in. As you exhale, feel soft vibrations controlled by your breathing while your breath is funneled to lengthen your exhale. The longer you exhale, the longer you feel the calming vibrations. This lengthening of your exhale activates a neurological calming response.

Focus

Continue to breathe through the device, focusing on the vibrations you feel, and trying to elongate them. As you calm, try to exhale long enough to feel the vibrations completely fade out before inhaling again. If possible, as you regain composure, start to breathe in through your nose and out through your mouth, still breathing out through the device.

Recover

Focusing on this physical manifestation of your breath helps distract you from a racing mind. Continue repeating this process until panic attack symptoms fade and breathing returns to normal.

For Use **On the Go**

Panic attacks can occur anywhere, at any time, so Para is designed to travel with the user to be accessible whenever, and wherever, it is needed most.

Para is discreet so that it may be used in public without fear of drawing attention. The device is kept clean during transportation with a hard plastic cap. The cap also includes a worry stone, so tactile relief is accessible without needing to uncap the device.

The cap is form-fitting, so it can be removed quickly and easily during panic, while remaining secure during transportation.

Para is durable, allowing it to be transported in backpacks or sports bags.

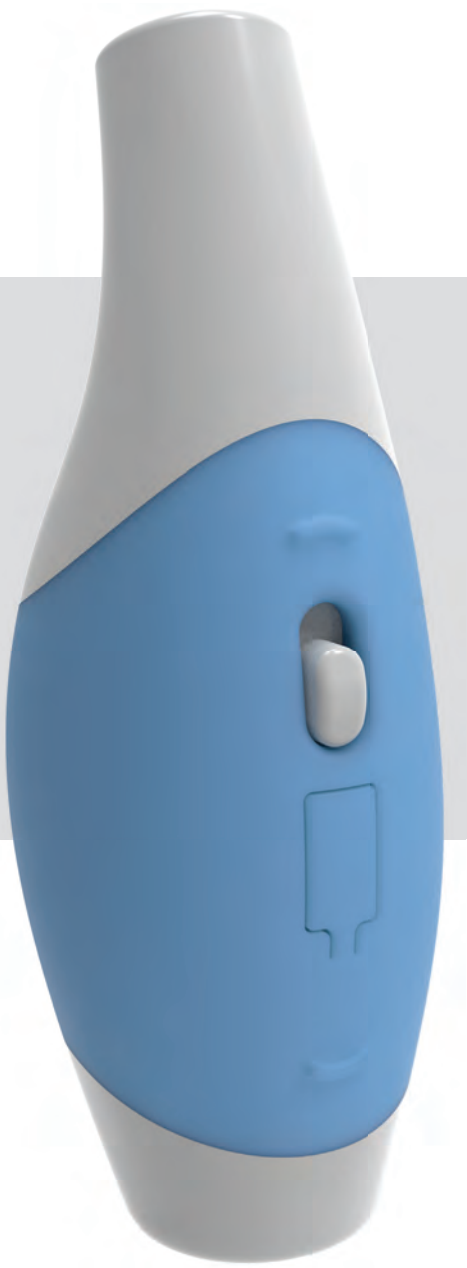
Para is also small enough to be transported in purses or bags with limited capacity.

Simple **User Interaction**

Panic attacks are experienced differently by different people. Para has different modes to be as effective as possible for as many people as possible without creating a complicated user interaction.

Mode 1: Panic Attack

Mode 2: Mindfulness



The device is controlled with a three-position slider on the back face. The low profile slider allows for easy movement while keeping the device comfortable to hold.

Off

Panic Attack **Relief**

Mode 1: Panic Attack

Panic attacks are alarming and sometimes unexpected, so Mode 1 is easily activated by sliding the switch to the far opposite position at the top of the slot. This mode matches the soothing vibrations to the user's breathing to create a sense of calm.

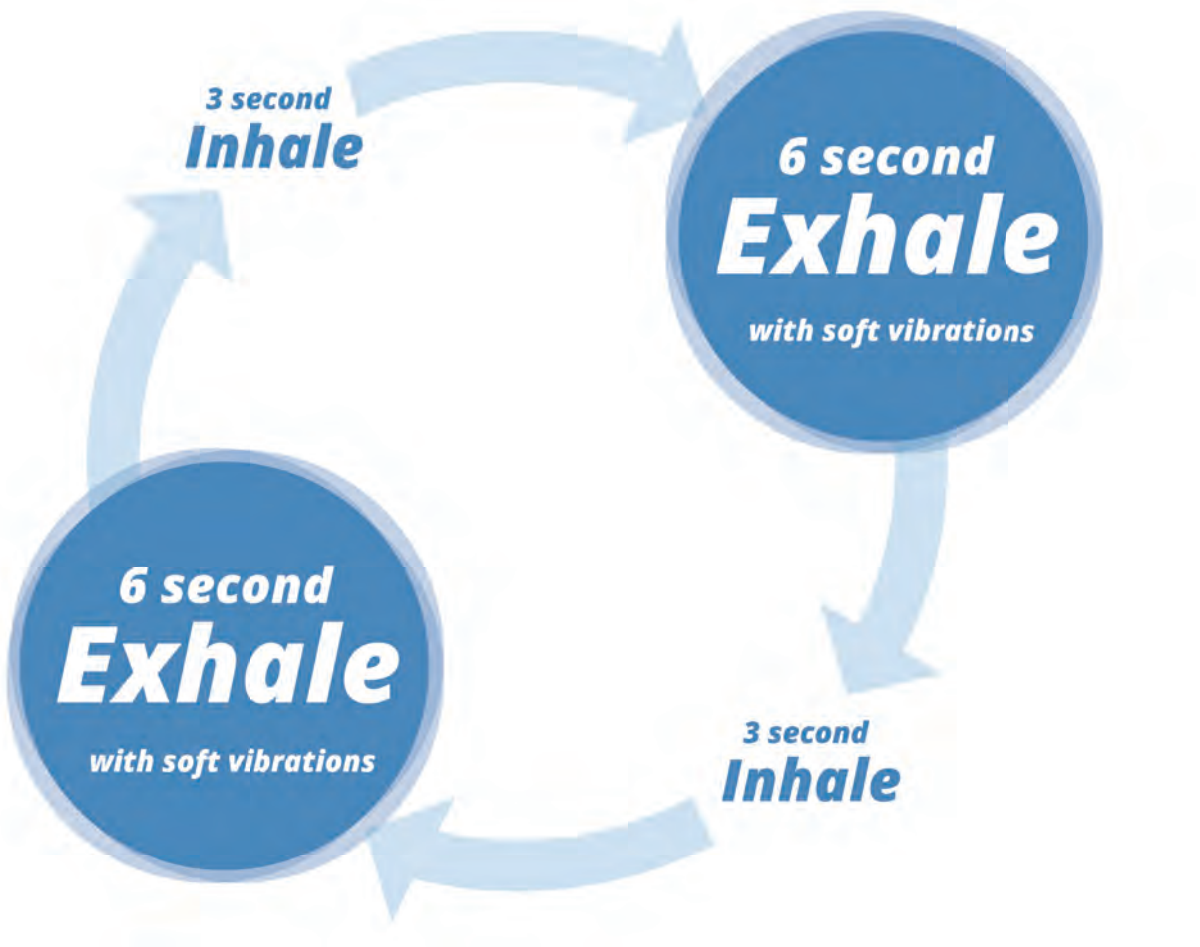
Para is small and discreet so it is able to be kept within reach at all times, even in professional settings. If you feel the onset of a panic attack, reach for your device.

Para fits discreetly into the palm to be used without drawing attention. Breathe through the device and feel the calming, fading vibrations match your breath to elongate your exhale.

Panic Attack **Prevention**

Mode 2: Mindfulness

Para can also be used to assist with mindfulness exercises to prevent panic attacks. Mode 2 is activated by sliding the switch to the middle position. In this mode, the user matches their breathing to a timed vibration cycle. The user may still breathe through the device, but they are also able to keep it in their hand.



Mindfulness exercises help to create better breathing habits and reduce stress. Para can assist with daily mindfulness exercises in the home to preventatively treat panic attacks.

Worry-Free **Charging**

Off / Dead Battery

The device is off when the slider is positioned at the bottom of the slot. While the device is most effective when charged and on, it can still be used if the battery is dead.

If the device has a dead battery, the user's exhale will still be restricted to create a calming response; however, the device will not vibrate with feedback.

Para has an LED indicator light that is exposed when the slider is moved into either on position. When turned on, the device will show a green light if the battery level is high. When the battery is low the indicator light will turn red, alerting the user to charge the device soon.

Even in the off state, the device still lengthens exhale and accounts for hyperventilation, serves as a focus object, and incorporates tactile calming with the worry stone thumb groove.

Lengthen Exhale

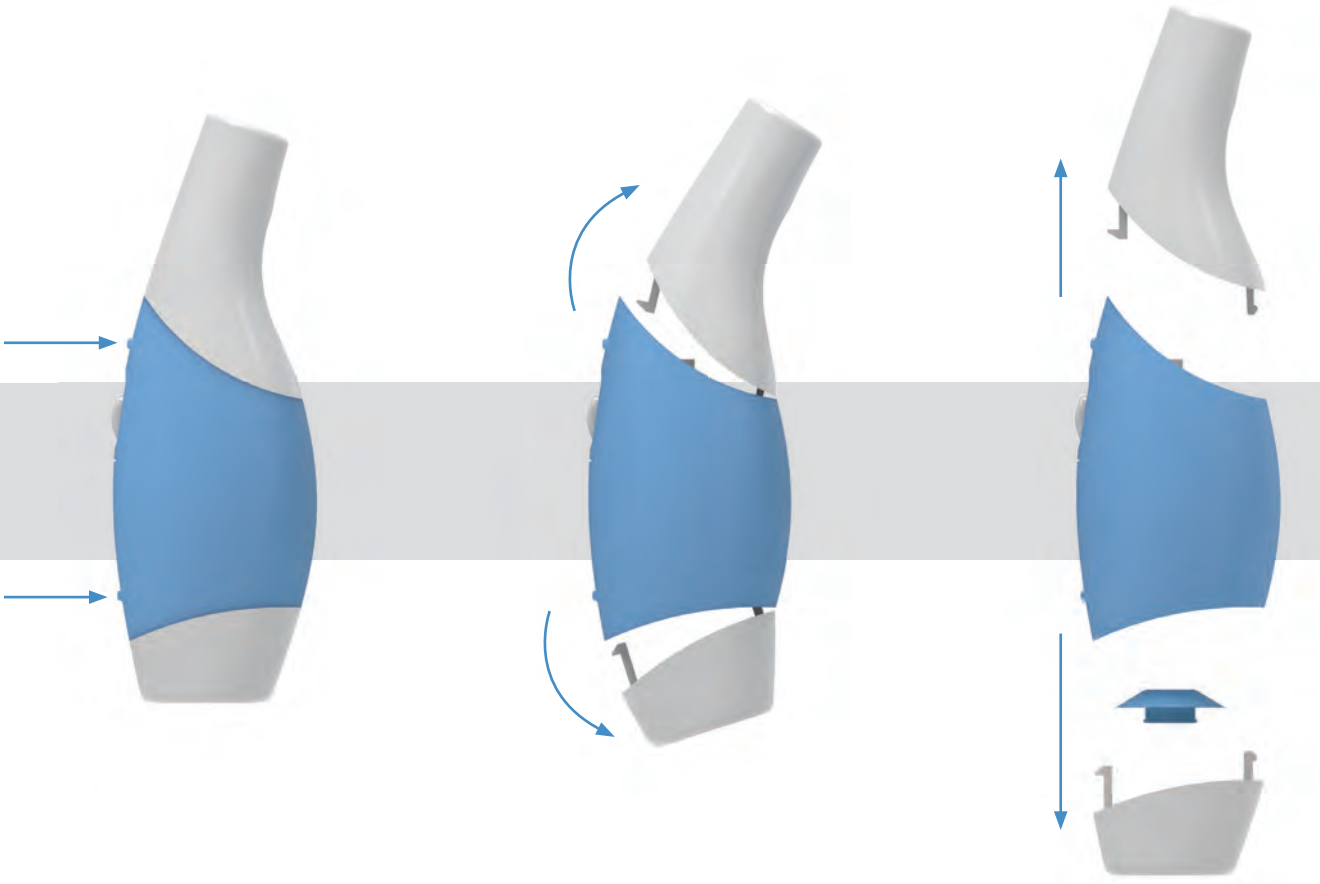
Focus Activity

Tactile Elements

Para is easily rechargeable through a Micro USB port on the back face.

How to **Clean**

Para has a simple 3 step disassembly process to clean the components without damaging the electronics within the device.

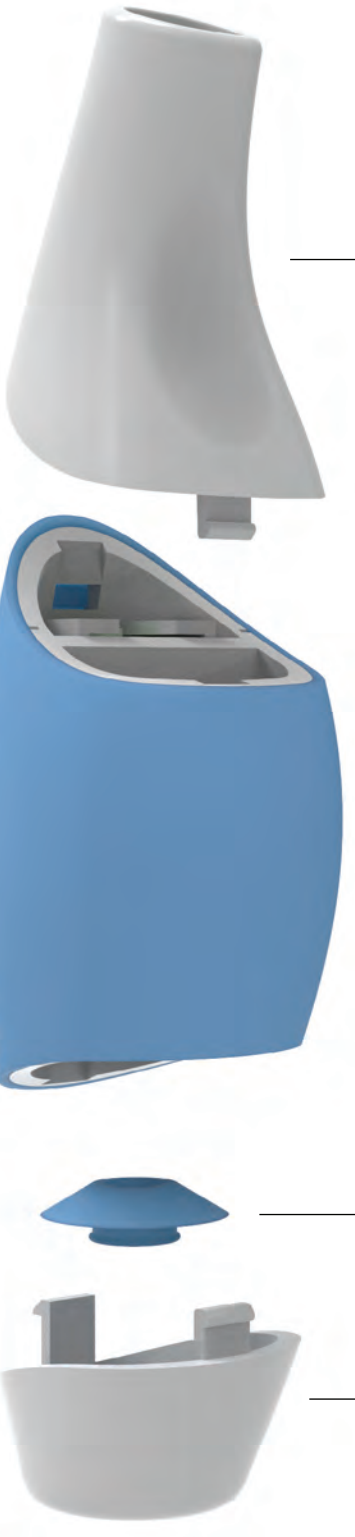


Press at indicators

Hinge piece forward

Pull to separate

The valve is press-fit into the center hole of the bottom piece and is held in place between grooves on the silicone.



Soak in soap and water

AVOID WATER
Airway channel can be cleaned using a disinfecting wipe

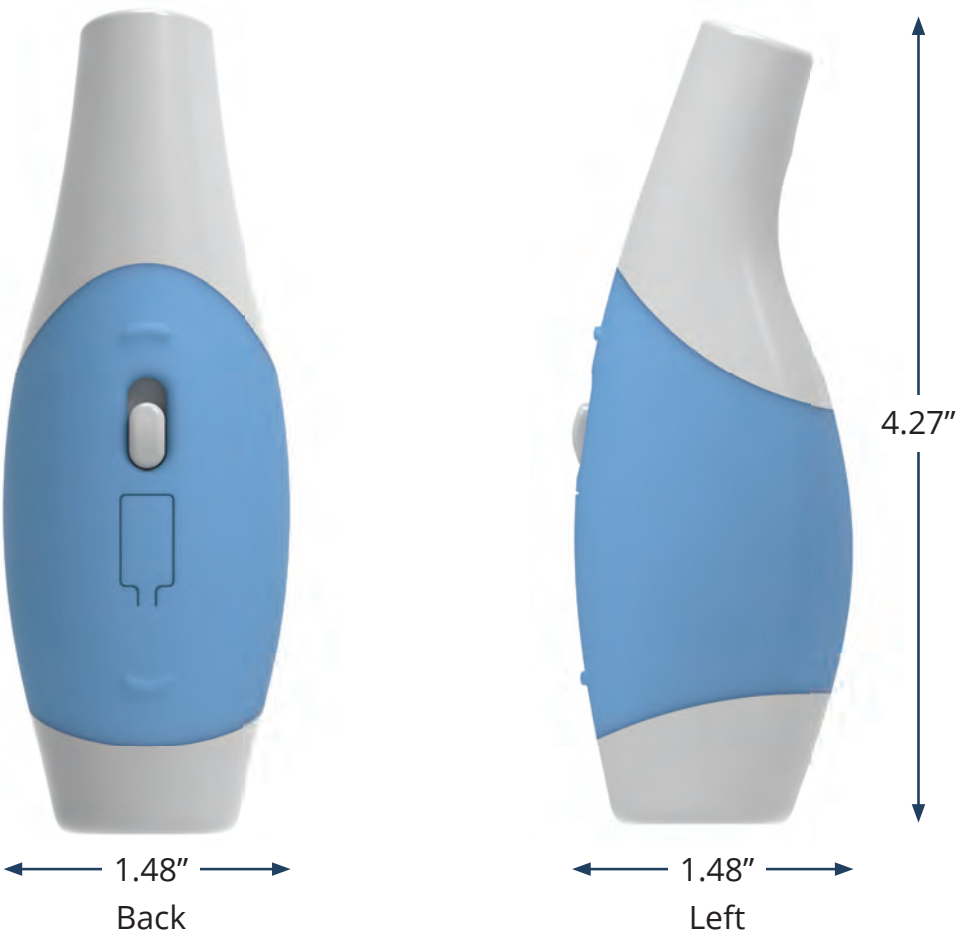
Soak in soap and water

Soak in soap and water

Calming **Colorways**

Product Specifications

Orthographic Views



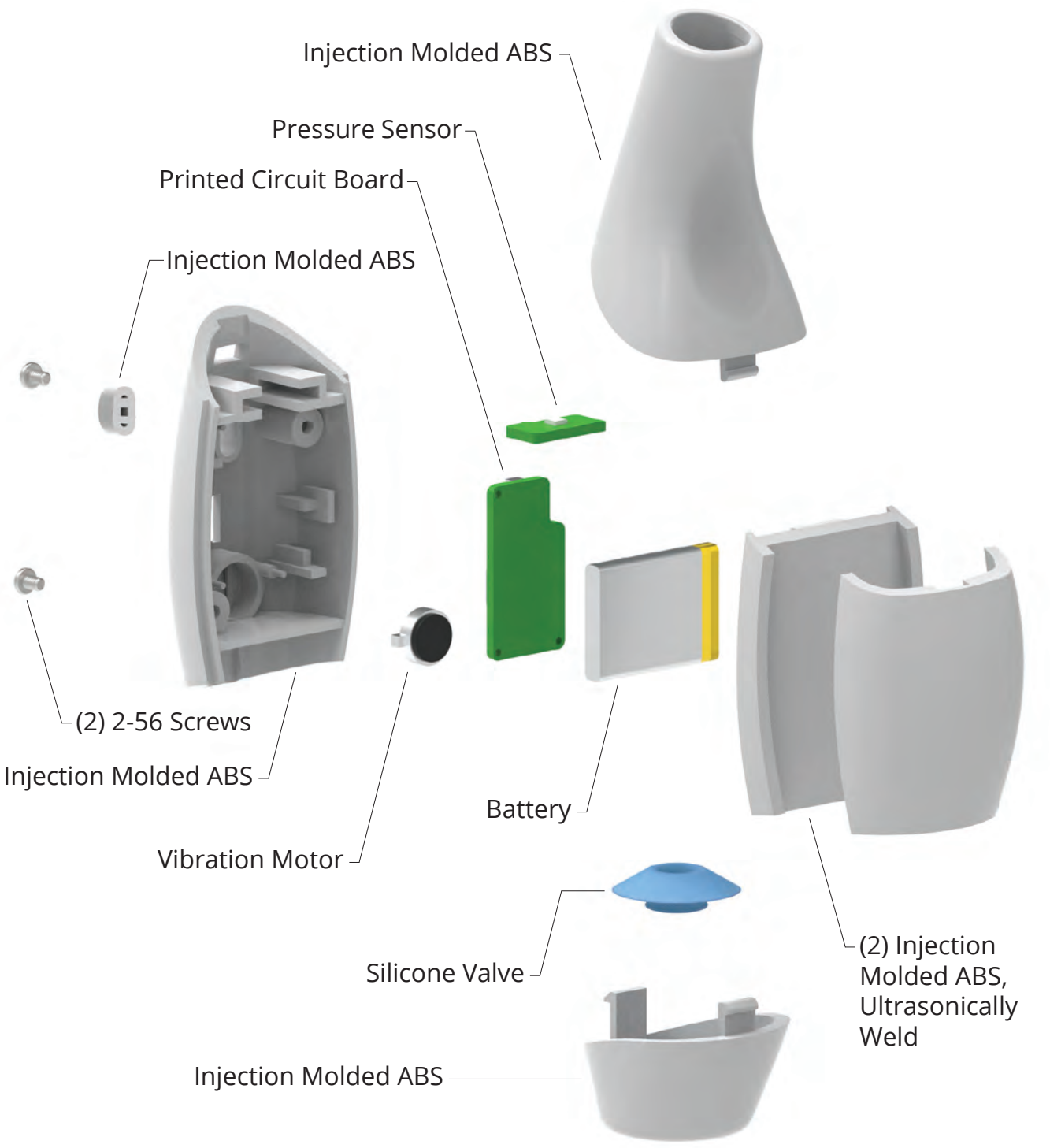
Top

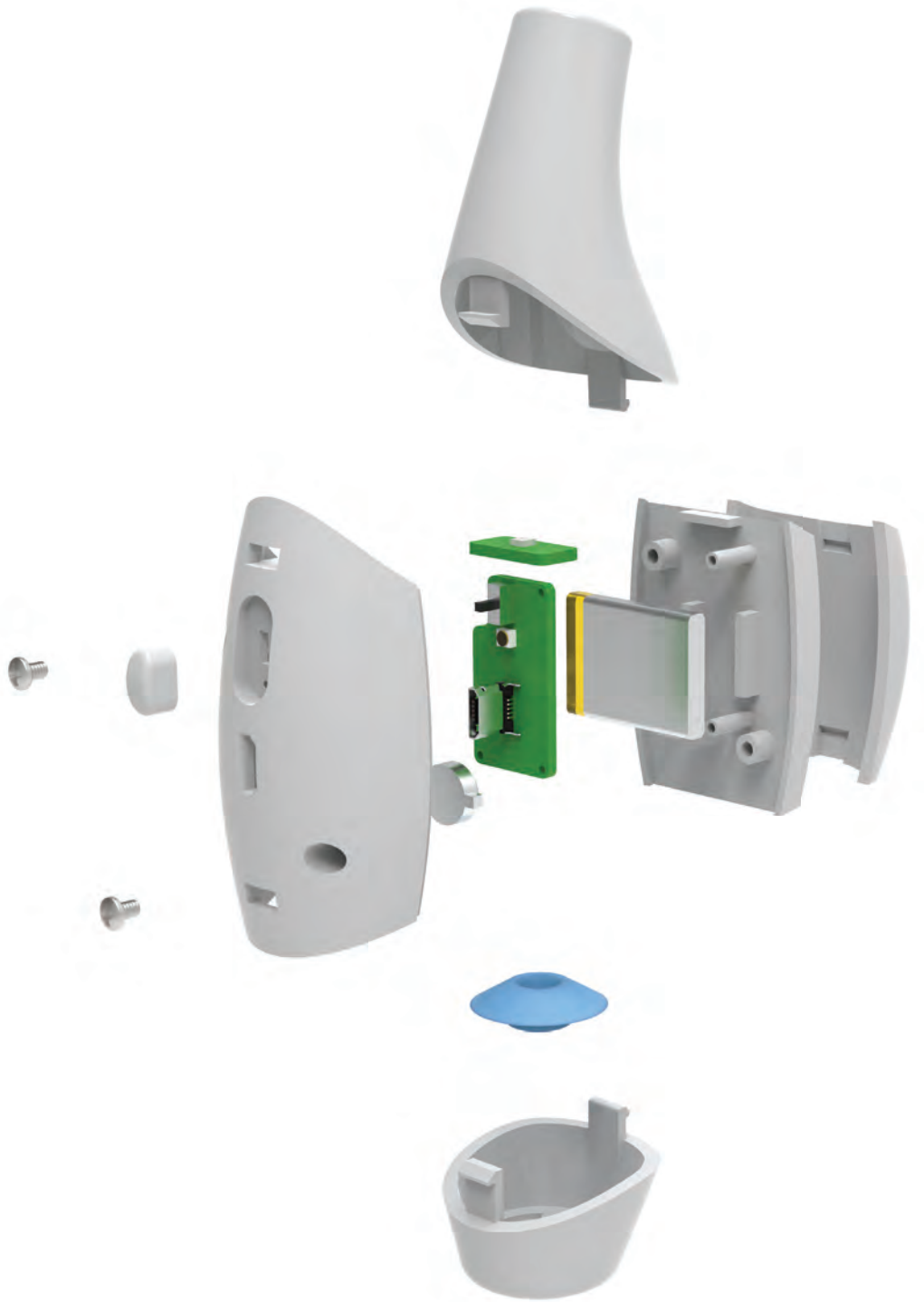
Front

Right

Bottom

Manufacturing





Process of **Assembly**

Ultrasonically weld the front two pieces together

Insert the vibration motor

Insert the circuit board and pressure sensor

Press on the sliding switch cap

Process of **Assembly**

Insert the battery

Close the front and back halves

Secure the front and back halves with two screws

Assembly of electronics is complete, cover mid section with silicone shell

Process of **Assembly**

Insert the valve into the bottom

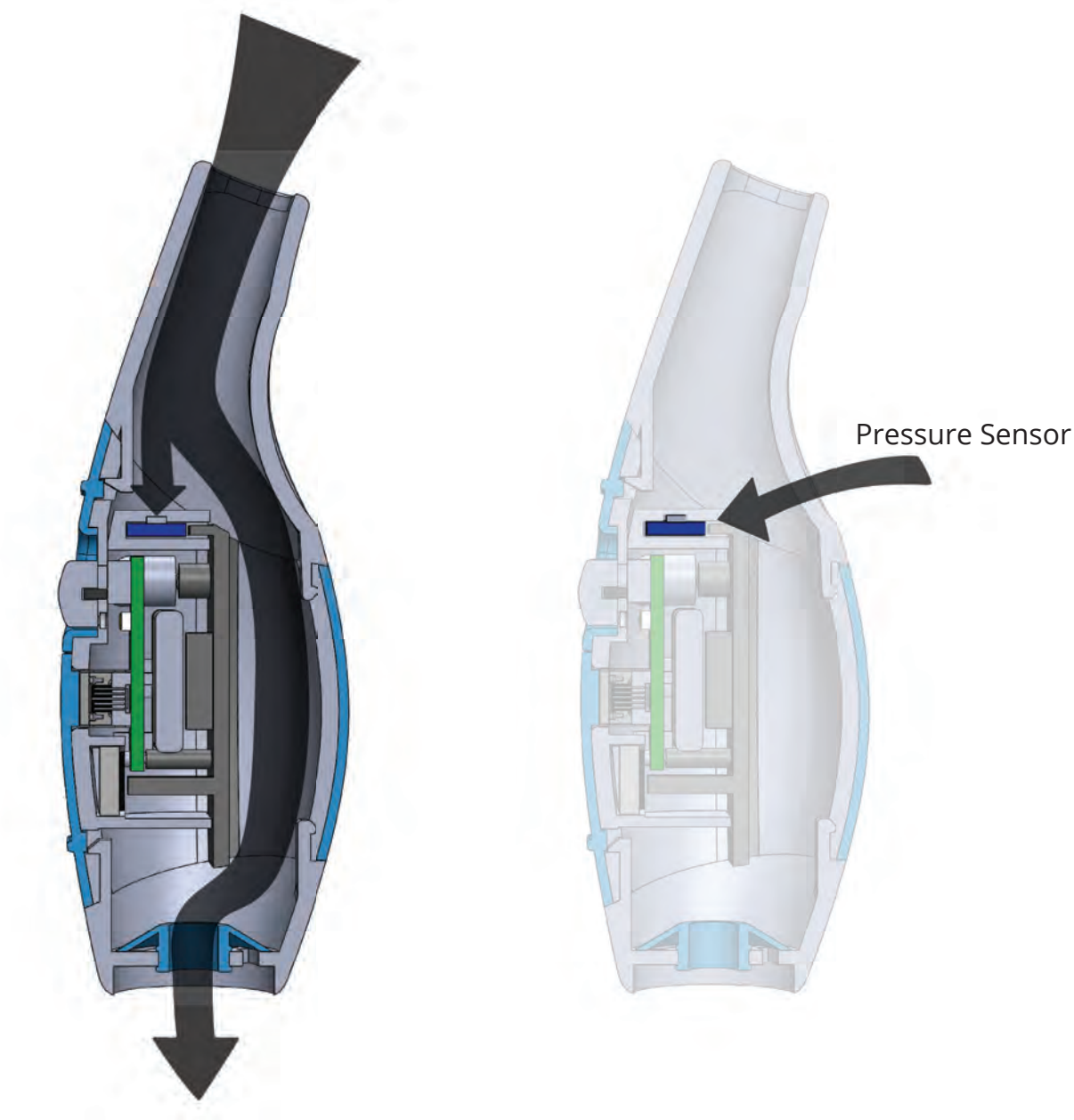
Snap the bottom and valve into the main assembly

Snap the mouthpiece into the main assembly

Assembly is complete

Internal **Details**

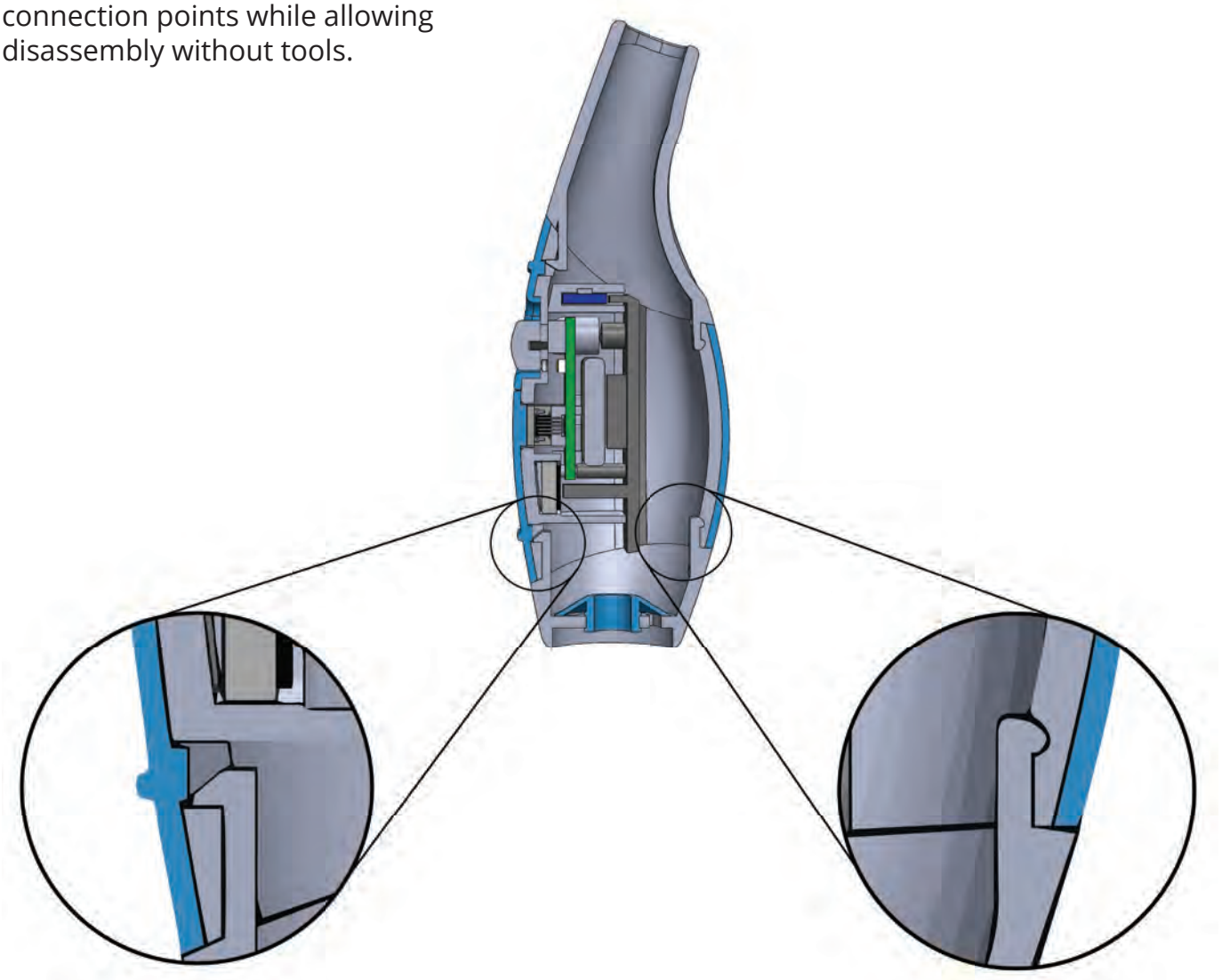
Airflow and Breathing Detection



All electronic components are contained in the back half of the device where they are shielded from airflow. The pressure sensor is exposed to detect breathing as air passes through the mouthpiece and airway channel in the front of the device.

Connection Points

Para uses a snap and hook mechanism that adds durability to connection points while allowing disassembly without tools.

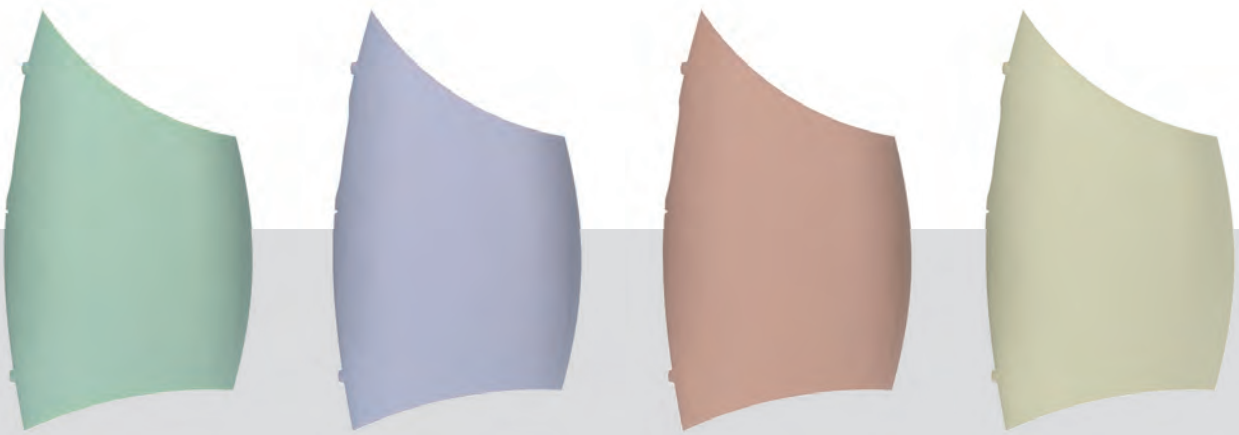


There is a snap on the back of the mouthpiece and bottom to connect pieces to the main assembly. Push at the indicator on the outer shell to disengage the snap.

There is a hook on the front of the mouthpiece and bottom. After disengaging the snap and hinging the piece forward, the hook will disengage and the piece can be removed.

Personalization

A silicone sleeve covers all parting lines and screw bosses while adding the opportunity for different colors to further personalize the user's experience.



Thank You

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Jefferson University Industrial Design Class of 2020

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...and many more who were willing to share their mental illness experiences with us in order to help others

Jessica Monteleone | Hannah Smythe

Thomas Jefferson University
Industrial Design Class of 2020