Breathing Pacer Device for Stress and Anxiety Relief

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Breathing Pacer Device for Stress and Anxiety Relief

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Abstract

Stress and stress-related physical and mental diseases are increasing and affecting more people every day. There have been many approaches to try to solve this issue. Many of them are based on the idea that meditation and mindfulness breathing could improve these conditions. The problem is that not everyone can achieve those levels of meditation for that to work. Another issue is that those solutions are relying on a particular way of breathing to help all.

In contrast, this project developed under research that shows that the amount of CO₂ in a person's exhaled breath could be an indicator of their mood. How much, and for how long we take in oxygen could reveal data in our exhale breathe to tell us in which specific state we are. Controlling the physiology of our breathing seems to work faster at the moment of the stress symptoms happening. This device has the intention of telling the user in which rhythm it makes more sense for them to breathe according to their specific physiology state.

In this context, there was a need to keep looking at competitive products to see what works and what does not. This exploration was done to see if the technology applied in the capnography could be implemented into this device to control the exhale breathing readings. User testing, interviews with experts in electrical engineering, meditation, people suffering from stress, anxiety, and panic attacks helped to inform the development of this project. The result is a friendly hand-held device, intuitive to use and with subtle vibration feedback to interact with the user. The people I interviewed seemed interested in this product and willing to use it, but further research is needed in this matter. Also and long-term research is required, perhaps with a more significant sample of people to see the progress of people suffering from stress and identify any other issues that may occur while using the device for a more extended period.
1. Introduction

People experience stress episodes more often than ever before in their daily lives. Our hectic way of life and our daily routines could be the triggering factor of this increase. Every day is more common to hear as a diagnosis from health practitioners, that the cause of pain or an organ malfunction is due to the amount of stress a person has been experiencing lately. Stress keeps growing worldwide. Mainly, in the US, 55% of the population experience stress during the day, according to the latest Gallup’s 2019 data on emotional states report. From the 143 countries studied in this poll, American society showed an average result of 20% more stress than the rest of the world. This report also showed that the average age of the people with most stress was between 15 to 49 years old (younger Americans). Natural products are being offered as a solution to help people deal with stress, such as aromatherapy, noise sound machines, painting, meditation apps, and so on. Some of these seem to be shallow or not helpful enough solutions. Although there are medications to treat the diseases caused by stress or to treat anxiety and depression, would it not be better if we go to the source of the problem? Juggling with financial stress, workload increase hours, shorter deadlines, daily responsibilities, family, kids, etc. might make people feel overwhelmed and stressed. Unless people drastically change their way of life and routines, these sources of stress will stay and possibly increase. The best thing people can do at this point is to learn how to deal with stress, listen to their bodies, and teach them to take control of a stressful situation. Some people try to do this through mindful meditation.

Mindfulness\(^2\) is a mental process that allows people to bring their attention to what is happening in the present moment without judgment, training their minds through consciousness of breathing. A person can develop this ability by practicing meditation consistently. Mindfulness is part of the Buddhist traditions that ultimately intend to look for spiritual enlightenment. Mindfulness practices are scientifically recognized after numerous studies have demonstrated its multiple benefits to fight against stress and even addictions\(^3\). Also, it has been used in clinical psychology for therapy programs to treat stress, depression, and as a strategy for behavior change. Although mindful meditation practice has positive benefits, there are concerns. It is used in other fields as well, like business to improve working functioning, to be more efficient, which is not necessarily a bad thing. However, it distances itself from its original purpose. In the framework of Buddhism, it is considered a power used to reach a nirvana state. Consequently, mindful meditation is not for everyone, especially for someone without the appropriate training. Not everyone can get to a certain level of practice to achieve a state of relaxation or deal with the deepest levels of meditation. If someone uses it without appropriate guidance, it could have unwanted effects such as fear, anxiety, panic, or also it is suggested that it could awaken bipolar vulnerability\(^4\). Mindfulness has been commercialized to the point that it looks more like a marketing strategy than a spiritual practice.

One of the main goals of this thesis is to avoid for the solution end up contributing to the McMindfulness tendencies to stop the commercialization of mindfulness. Stress and mental

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health are complicated issues, so obviously, a single product would not magically solve these problems. By any means, this product will replace medication or therapy, but the main goal of this project is to empower people to control their breathing to reduce stress. Give them a science-based tool to help them monitor their physical symptoms to analyze this data with their doctors later and hopefully improve their stress and anxiety over time.

2. Background

2.1. Difference between worry, stress and anxiety

Commonly, worry, stress, and anxiety are terms used interchangeably, but they are different from each other, and it is important to recognize these differences to help us know the scope of aid this product will have.

Worry is the repetition of negative thoughts that occupy a person's mind about things that could go wrong. These thoughts are recurrent and even obsessive, but they are happening in one person's mind. In a way, they are useful to have because they stimulate our minds and help us to be prepared or take action against a problematic situation. If we get stuck on a negative thought that is when worrying stops being helpful.

The Merriam-Webster dictionary defines stress as "a physical, chemical, or emotional factor that causes bodily or mental tension and may be a factor in disease causation." It usually is triggered by external factors such as the environment, a social situation, a heavy workload, or pressures of other kinds. Stress initiates the "fight or flight" response, which is a natural reaction

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to threat. Once this response is activated, cortisol and adrenaline are released into your blood vessels. These hormones prepare the brain and body for the threat.

Finally, anxiety happens when you have a lot of worry and stress to deal with. It manifests in both mind and body. However, the difference between anxiety with stress is that the threat is non-existent. Physically, it also activates the "fight or flight" response making your body work in the same way it does for stress but without a real threat. Also, there is a difference between feeling anxious and having an anxiety disorder\(^6\). Feeling anxious is an expected consequence of stress, and it should be temporary and not happen very often. An anxiety disorder instead is a more serious medical condition. It manifests unexpectedly, frequently and intensively and with no real reason.

2.2 **Symptoms of how stress manifests physically in our bodies.**

Our bodies, particularly our nervous system, are wired to respond when we feel threatened or in danger (stressors), this response as it was mentioned before, is called the “fight or flight” or stress response which prepares us by putting our bodies in alert mode to cope with these “dangers”. Adrenaline, noradrenaline and cortisol hormones are released in our blood vessels. As a consequence of that, the heart rate increases, it raises your blood pressure, and respiration rate. This is not harmful if they happen for a short period of time, but the continuous activation of this response causes a severe impact on a person’s general health. According to data from the American Psychological Association\(^7\), on the sample of people experiencing physical symptoms due to stress, 51% experience fatigue, 44% headache, 34% an upset stomach, 30%

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muscle tension, 23% change in appetite, 17% teeth grinding, 15% change in sex drive, and 13% feels dizzy. Also, the results showed psychological symptoms, 50% irritability or anger, 45% feeling nervous, 45% fatigue, 48% insomnia.

The respiratory system\textsuperscript{8} is also immediately affected when the stress response is activated. Our breath becomes harder and faster because unconsciously, we are trying to get more oxygen throughout our bloodstream. This may cause hyperventilation episodes, especially if the person tends to have anxiety or panic attacks.

Besides the physical disorders, the constant exposure to short and long-term stressor can lead to other mood disorders that consequently can develop into serious mental health disorders such depression, anxiety, and post-traumatic stress disorders\textsuperscript{9}.

2.3. Breathing, CO\textsubscript{2} and Capnography

Since we were born, we knew how to breathe properly, fully engaging our diaphragm to take in deep and fresh air. Diaphragmatic breathing naturally slows down or heartbeats and stabilizes blood pressure but as we grow older, we grow out of this habit. We start to pull in our stomach to look slimmer, or without even noticing we do it due to stress. For whatever the reason is, we force ourselves to have shallower and shorter breaths. We limit ourselves to breathe only through the chest, and this becomes our new normal.

When we breathe, we inhale oxygen, and exhale Carbon Dioxide. The oxygen goes to different tissues of our bodies and helps us to break down foods into energy before transforming it into waste as Carbon Dioxide in every exhale breath we have. As the body reacts at different


stressors, CO₂ changes occur at the same time. The levels of CO₂ in the blood could say a lot about what is happening in a person's body. A normal respiration rate (number of breaths per minute) in an adult individual at rest is 12-16 breaths per minute\textsuperscript{10}. A variation of your RR together with your CO₂ levels could be a signal that something is going on. These abnormal parameters could be due to anxiety, respiratory problems, heart failure, narcotic use or drug overdose. Between the available technologies to measure these values, one of the most accurate and fastest ones is the capnography.

A capnogram is a device normally used in anesthesia procedures and intensive care. It is a noninvasive, continuous monitoring of the amount of CO₂ in a person’s respiratory gases over time. \textit{See figure 1}. It gives physiological function ventilation, cardiac output and cellular metabolism\textsuperscript{11}. \textit{See figure 2}. The combination of these values could give a capnography value to tell a specific condition of the patient.

\textbf{Figure 1\textsuperscript{12}. - Breathing phases:}


Page 7
A-B $\rightarrow$ Dead space ventilation

B-C $\rightarrow$ Ascending expiratory phase

C-D $\rightarrow$ Alveolar plateau

D $\rightarrow$ End-tidal CO$_2$

D-E $\rightarrow$ Descending inspiratory phase

*Figure 2: Monitoring functions of the capnography*

There are similar terminologies used in this area and it is important to know the difference between them. Capnometry is the numeric value, quantitatively it tells you how much carbon dioxide is being exhaled in millimeters per mercury (mmHg) also known as End-Tidal CO$_2$ value (EtCO$_2$). In a Capnography device it is normally shown together with a Capnogram, which is the graphic representation of how much CO$_2$ is present in each phase of the respiratory cycle (waveform). Waveforms together with their numerical value, could indicate different conditions. *See figure 3.*
A normal EtCO$_2$ reading should be 35-45 mmHg, the waveform height should match this numerical value and it always should return to the baseline. See figure 4. The waveform frequency should be the same as the respiration rate of the patient.

Capnography mechanism uses infrared radiation to measure CO$_2$ molecules. They absorb infrared radiation, the amount of radiation absorbed is in relation with the concentration

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of CO₂ present in the breath sample. The amount of light that goes through the sensor is inverse to the amount of CO₂ present in a person’s breath. *See figure 5.*

![Gas molecules](image)

**Figure 5: How the Capnography works**

Capnography\(^{14}\) is a standard tool in health care, not only for monitoring the respiratory system but there are other potential applications out of the emergency or operating room.

### 2.4. Breathing techniques to help with stress/anxiety

There is commonly known that certain breathing patterns\(^{15}\) are directly related or could indicate certain moods. When someone is stressed or anxious one thing their health practitioner will advise is to slow down, calm down, and to try breathing exercises to control their timing and pace. The goal of this is to focus their attention to their breathing and regulate their nervous system. For years it was believed that the brain stem was responsible for the breathing process but new research\(^{16}\) shows that breathing also uses neural networks that are connected to emotion,

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attention and body awareness. For example, the study showed that breathing at a fast rate triggers feelings such as anxiety, anger or fear. Taking advantage of these networks using intentional breathing, it gives individuals a powerful tool for controlling their stress levels.

2.4.1. Pranayama breathing

Pranayama breathing\(^\text{17}\) is a controlled breathing practice that is commonly used in yoga and meditation. Consists in control of your breathing in 3 phases\(^\text{18}\), inhaling for 4 seconds, retaining for 7 and exhaling for 8. \textit{See figure 6}. This technique is also known for being effective on treating stress-related conditions. According to experts of this practice, this breathing technique is particularly useful because it helps people who have a hard time concentrating when meditating due to its passiveness. On the other hand, pranayama practice is an active exercise in which you need to concentrate on your breath and in each phase, quieting negative thoughts in your mind.

\textbf{Figure 6: Pranayama breathing method}

\begin{figure}
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\includegraphics[width=0.5\textwidth]{pranayama Método.png}
\caption{Pranayama breathing method}
\end{figure}

2.4.2. Cognitive Behavioral Therapy

Cognitive Behavioral Therapy is a short-term psychotherapy technique used by therapists. Within few sessions, CBT promises to modify negative or dysfunctional patterns in behaviors, emotions, or thoughts to fight against depression, anxiety, alcohol & drug abuse, eating disorders, marital problems, and other severe mental illnesses. This therapy works on your present behaviors instead of looking for answers in your past. According to a Mayo Clinic article\textsuperscript{19}, CBT usually follows these steps: “1) Identify troubling situations or conditions in your life. 2) Become aware of your thoughts, emotions and beliefs about these problems. 3) Identify negative or inaccurate thinking. 4) Reshape negative or inaccurate thinking.”

2.4.3. Capnometry-Assisted Respiratory Training study

Capnometry-Assisted Respiratory Training (CART\textsuperscript{20}) is a treatment proved to be more effective than CBT in a study made by the Southern Methodist University in Dallas. This study showed that changing the levels of carbon dioxide changed panic symptoms.

During the study, patients practiced breathing exercises with a portable capnometer device twice a day, which gave them instant feedback while exercising on their CO\textsubscript{2} levels. The goal of the exercise was to reduce hyperventilation and panic symptoms with slower and shallower breaths. The common belief is that if someone is hyperventilating, they need to breathe deeply, but by doing so, they could worsen that state\textsuperscript{21}. In their study, they noticed that CBT did not change respiratory physiology, while CART effectively reduced hyperventilation.

"CART, however, tells us a patient's CO₂ is very low and is causing many of the symptoms feared, but it can also show how to change these symptoms through correct breathing. There has been an assumption that if people worry less about symptoms, it will also normalize their physiology, but this study shows that this is not the case. Hyperventilation remains unchanged, which could be a risk factor for relapse down the road. Apart from hyperventilation being a symptom generator, it is an unhealthy biological state associated with negative health outcomes." said psychologist and panic disorder expert Alicia E. Meuret, one of the researchers conducting this study.

2.6. Competitive Benchmarking

2.6.1. Breathing friend: According to its website description, it is a hand-held-anti-stress gadget that pulses at a specific speed and frequency to calm a person down in a tense situation. The user could customize it in their mobile app. It focuses on tactile perception and intuition to train a person’s breathing. See figure 7.

Figure 7: Breathing Friend - Competitive Benchmarking

[Link to BreathingFriend.com](https://breathingfriend.com/en)
2.6.2. B breathing tool\textsuperscript{23}. It is a pocket-size device designed to help track and cultivate mindfulness through guided breathing. It uses a pressure sensor to measure breathing. Together with audio and visual cues to help the user to track and practice what they call “mindful breathing.” See figure 8.

![B Breathing Tool](image)

*Figure 8: B breathing tool - Competitive Benchmarking*

2.6.3. Freespira\textsuperscript{24}: According to their website, Freespira is FDA-clear digital therapeutic drug-free solution to reduce/eliminate the symptoms from a panic attack. It is not used when a panic attack happens but is used to present or reduce future panic episodes. It teaches the user to stabilize their breathing patterns observing their exhaled carbon dioxide levels to put them in a healthy range. To be used, it needs to be licensed by a licensed healthcare provider. The length of this treatment is a few minutes, twice a day, for 28 days. The treatment includes a tablet, a sensor to measure breathing rate and Carbon dioxide levels, a training coach, and a review and reporting of the person’s progress. See figure 9.

\textsuperscript{23} http://breathewithib.com/
\textsuperscript{24} https://freespira.com/
2.6.4. Power Breathe: It is a line of breathing trainers used to improve lung capacity, strength, stamina, and to reduce breathlessness. It uses Inspiratory Muscle Training (IMT) to make your lungs “workout,” creating resistance when you breathe in. It is meant to be used by people with breathing problems to Olympic athletes. See figure 10.

25 https://www.powerbreathe.com/
2.6.5. Respa\textsuperscript{26}: It is a sport-oriented device line. It aims to improve sports performance and training. It has a breathing sensor that works analyzing breathing patterns that correlate directly with a person’s lactic threshold and ventilator threshold. Both values indicate the state of a person’s cardiorespiratory fitness level. The device gives real-time feedback to give a boost to a person’s workout. It gives the user real-time alerts to let them know when they could push harder or slow down their workout. Also, it keeps track of data in a simplified app. \textit{See figure 11.}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{respa.png}
\caption{Respa - - Competitive Benchmarking}
\end{figure}

2.6.6. Comparative diagram and conclusions

As mentioned before, there are many natural and simplistic solutions offered to deal with stress and anxiety, but the ones mentioned in this section go further. Nevertheless, they still lack some qualities to make them effective. Breathing Friend and B Breathing Tool are interesting solutions, but they are relying on predetermined breathing rhythms to make people regulate their breathing. They make people customize the rhythm according to their preference but without

\textsuperscript{26} https://www.zansors.com/respa
knowing what the person’s physiological state is. Freespira, on the other hand, uses physiological information to regulate people’s breathing, but it seems too complicated, big in size, and you need a prescription to use it. Although the last two options are meant to improve breathing performance for training or sports, it is interesting to see their approach in terms of use because they show clever ways to attach it to the cloth in a discrete way as Respa does and no so functional ways like power Breathe mouthpiece, is too big and seem uncomfortable. See figure 12

![Comparative diagram - Competitive Benchmarking](image)

*Figure 12: Comparative diagram - Competitive Benchmarking*
3. Concept

With this research and technology available on supporting better breathing, the intention of this project became clear. A hand-held device that will helps users to train, take control, and keep track of their breathing patterns receiving feedback based on their CO₂ levels. The user will get subtle and straightforward input from the device, but the capnography-complicated data should be for their health provider to check.

3.1. Problem Statement

How might we help people to take control of their own breathing-pace to improve their wellbeing?

3.2. Design Goals

After research and comparing other products available that help to regulate breathing pace, certain features will be important to have in this solution:

- Physiological monitoring (CO₂ readings)
- Intuitive in its use
- Regulates breathing
- Feedback haptic cues
- Hand-held or pocket size
- Save data from breathing patterns
- Easy to clean
- Fidgeting characteristic
3.3. Hypothesis

People who suffer from stress and anxiety could use an alternative-effective solution to take control of these conditions throughout their breathing and possibly reduce (not eliminate) their need to take medicine.

3.4. User persona

The research showed that in America, the people most affected by stress are people between 15-49 years old, so the user persona was built around that. Also, this solution is aiming for people that are stressed or anxious but not necessarily suffering from a serious mental health condition. It meant to be preventive and teach people how to control their breathing. See figures 13, 14, 15, 16.

Sandra DREAMER

- 25 years old
- New York
- Marketing assistant
- Single, lives w/parents
- $48300/year
- No mental illness diagnosed

Bio: Single. She has a degree in advertising. Currently, she lives with her parents because of her student loans, but dreams to have her business someday. Recently, she joined a yoga gym because she cares about her mental and physical health.

Goals
- Living a balance-healthy life.
- Move out, form her parents’ home.
- Take advantage of life opportunities.

Pain points
- Sometimes she gets emotional at work and feels that her feelings take control over her.
- She worries about people’s criticism of her living with her parents.

Figure 13: Sandra/Dreamer, User persona
**Chris RISK-TAKER**

- 48 years old
- Chicago
- Business owner
- Married, 2 daughters
- $152000/year
- No mental illness diagnosed

**Bio:** He is married, with two daughters in College. He worked for a company for 25 years. He was able to retire at 55 years old. Now, he is investing his money in a bakery business. He enjoys spending his free time cooking for his family and friends.

**Goals**
- Finding natural ways to control his anxiety.
- Run a successful business and have a productive retired years.

**Pain points**
- His anxiety level improved after retiring but he still feels overwhelmed sometimes.
- He fears that he might have made a mistake retiring too early.

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**Nicole OVER-ACHIEVER MOM**

- 45 years old
- Boston, MA
- Researcher
- Married, 2 sons
- $104,000/year
- Anxiety and depression

**Bio:** Works as a researcher at a well-renowned University. She is married with two teenage sons. She loves to plan family trips. For the last six months, she has been practicing meditation, and she has seen some improvement with her anxiety levels.

**Goals**
- Help special needs son graduate high school.
- Balancing work and life while trying to advance the career ladder.

**Pain points**
- She suffers from cry-spellings because she feels overwhelmed with work and home responsibilities.
- She has difficulties finding ways to cope with stress.

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*Figure 14: Chris/Risk-taker, User persona*

*Figure 15: Nicole/Over-achiever mom, User persona*
3.5. Methodology

There was a mix of research methods used throughout the development of this thesis: interviews with experts and potential users, surveys, observation, competitive benchmarking, and data review. Data results from previous studies about stress, available technology, and haptic cues were also reviewed for this project.

4. Development

4.1. Phase 1 (Ideating)

At this point, it was not clear how the device would work exactly, but it was clear that it should have a sensor to monitor the CO₂. It should also have a filter to catch the humidity, a removable mouthpiece to make it easy to clean, ergonomic shape if it is handheld, gentle vibration, and visual cues to interact with the user and guide them through their breathing.
4.1.1. Sketching

I started exploring different shapes in 3 different categories: the first one was inspired by the vaping products thinking of it to be used like an accessory. Such as people do with vaping products, this could also be a device that they could carry with them and use it whenever they want. The second was inspired by mindful breathing as a ritual, and instead of making people use it unconsciously, for this one, they will have to stop and use it, holding it with both hands and intentionally use it, focusing on the act of breathing. Both of these categories would have to measure the CO$_2$ throughout the exhale breath in the mouth. The third category was thinking about finding a way to measure the CO$_2$ throughout the nose. It was inspired by nose ring jewelry and snoring aid products to try to make it discreet and elegant.

4.1.2. Prototyping

I used several materials to make 3D versions of the concept sketches and develop further the ones that, by holding them in my hand, felt and looked better. Also, this was especially helpful and informative to decide on the scale of each prototype for three concepts.

4.1.3. Testing

The initial testing was informal and given to a total of 15 people (convenience sample). I asked some questions about the prototypes, sketches, pictures, and video references I had. They were more questions related to the device's shape and feedback. To learn more about the mechanism of the device, I interviewed Dr. Dan Phillips (Associate Professor Department of Electrical and Microelectronic Engineering, Kate Gleason College of Engineering RIT), who confirmed some ideas about the type of sensors I needed for the device. Also, he brought to my attention the need for a water trap to deal with condensation and humidity for the device since we are not inhaling from it but exhaling.
4.1.4. Results, analysis and challenges

The testing results guided me to keep developing the second category further. One comment about the second category was that I should consider some type of grip to hold it better, considering its oval shape. The first category was close to the vaping products, which lately have had negative connotations because of discoveries associating the product with respiratory problems. The third category had the smallest percentage of the sample willing to wear it. In some of the comments, people said that they would not use an accessory in their nose independently of the use of the product. Also, it would be more complicated to fit the sensors in such a small piece. Another conclusion was that it makes more sense for the mouthpiece to be rectangular with rounded corners rather than circular or square. Although straws, for example, have been used for years and they are cylindrical, the size is small enough to make it comfortable when used. But if the cylinder is wider like in the case of a bubble tea straw, it makes it more awkward to use. The natural shape of our lips is more rectangular than cylindrical; therefore, the mouthpiece should follow that shape. This also helps the facial muscles to relax and avoid unnecessary effort. I also decided to eliminate the visual cues because the lights increase the anxiety, and together with the vibration, it becomes too overwhelming. *See figure 16.*
4.2. Phase 2 (Refining)

In this phase, I wanted to explore and define the workflow between the device and the user. At the same time, knowing the feasibility of the mechanism and defining which elements the device would need to work. Also, I wanted to define the shape and include new shapes, not just the ones that got better results in the previous phase.
4.2.1. Sketching

I refined the second concept from the first phase considering the previous results from the testing and also adding a refined version of the vaping-inspired prototype. I included a third one, which was a smaller prototype, meant to be held by the index finger of a person while using it.

4.2.2. Prototyping

At one point, I considered an idea to include an oximeter in the prototype, but since the exhaled breath into the device will give an instant reading of the Oxygen saturation, I discarded it. But the results of this exploration gave me ideas that would help users to hold the device better without the risk of slipping down through their fingers. See figure 17.

*Figure 17: Prototyping iterations*
4.2.3. Testing

In this phase, I interviewed and observed 15 people, different people from the first phase. Since I did not have a functional device, I divided the testing into three main parts. First, observing how people interacted with the prototypes without guiding the users in any way. The second part of the testing consisted of some questions about what I had observed before from earlier testing and some questions that I had prepared, including what type of material they preferred. In the third part of this research, I used an Arduino board that had set up three levels of vibration to learn which vibration would work better as feedback for the device. See figure 18.

![Figure 18](image)

Figure 18: In this phase, I interviewed/observed 15 people, different people from the first phase.

4.2.4. Results, analysis and challenges

In this round of testing, users were again more apt to pick up the circular prototype, and they “used it” as it was supposed to be used. Some users held the longer prototype in awkward ways. Some users were curious about the smallest prototype, but it took longer for them to discover the right way to use it. Having the indent on the right side in the circular prototype made it harder for left-handed people to hold it in a comfortable way. I tested several materials to learn what people liked from the characteristics of those materials. I learned that they like the warmth of the wood material, and also, they liked the texture and grounded feeling that the
stone had. In terms of the feedback, they went for the lowest setting of vibration mode, saying that they preferred that setting because it felt more soothing than the others.

5. Final Design (Defining)

5.1. Design Analysis

The final iteration shows soft curves all across the device. The main body is round, flattened in the top part. The mouthpiece follows the angle of the bottom curve to rise. The mouthpiece is made of hard rubber; it will be removable, which will make it easier to clean or put on the dishwasher. Also, in terms of size, the mouthpiece will be slim with soft edges. The material of the case is texturized hard plastic; the “grounded” quality will be given by the weight of the components inside the device. Plastic will be more forgiving in case it is dropped. The 3D model is a closer view of how the device would look at the end. See figure 19.
5.2. Exploded view / specifications

The device has an overall size of 2.33 in wide x 2.8 in long x 1.8 in height. The mouthpiece is 0.62 wide x 0.8 in long x 0.8 in height. See figure 20. It would work with a printed circuit board (PCB) that will have a vibration motor, gas sensor, accelerometer, humidity condenser, filter, and a rechargeable lithium battery with a USB connector. See figures 21.
Figure 20: Orthographic views
5.3. User Workflow and app developing

The use of the device attempts to be intuitive, and if there is any learning curve, it should be minimum. In the workflow (See figure 22), you could see how the device is simple in its use. The device will come with a user manual, but it does not require the manual to learn how to use it. While it is measuring the CO₂ and giving the vibration feedback, the device is saving the data. The data will show on a smartphone throughout the app. As it was stated before, the rough data is not relevant or easy to understand for the user. Consequently, the app will have a simplified User Interface where the data will show graphicly (See figure 23), and if the user wants to share it with his/her healthcare provider or therapist, the user could do so. Another reason for the User
interface simplicity is to avoid distraction, confusion, and visual clutter to prevent the user from feeling overwhelmed when is using the app.

*Figure 22: Workflow*
Figure 23: App User interface
6. Summary

The next step will be developing the prototype together with an electrical engineer to be able to test the real user experience with a functioning prototype. Testing the water trap would allow us to know if it would seal the electronics inside the device and protected them. Also, having a high-quality 3D printed version of the case would give us the closest version of the final prototype before production. The UI interface shown is the concept and look & feel of what the app should offer to the user, but also needs more work and user testing. Likewise, the name product, “Respifier,” should be tested to see if it would be easy to remember and in the case of the isotype if it would be easy to distinguish from other app icons.

7. Conclusions

Having the experience of friends and family members who suffered from stress, anxiety, and depression, it is rewarding to work on a project that could potentially help people with these conditions. To understand how, throughout their breathing, they could prevent disruptive or debilitating physical and mental conditions. The power of design to influence society goes beyond making things beautiful.

Hopefully, this project could continue and could be tested further and implemented to reduce the statistics of people suffering from stress. It would be interesting to see how far the data provided by this device could be useful for doctors and therapists to work on this and other conditions thought time.
8. References


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