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Anxiety Application & Wearable

My team and I were tasked to identify a problem within the Drexel and/or Philadelphia communities to address with a ubiquitous solution. This project is to have unlimited resources, financial backing, and the support of local policymakers. With this in mind, my team and I began brainstorming problems we would like to try to solve, or at least improve, so we decided we wanted to help people with mental health disorders, more specifically anxiety. We formed our research questions, 'How can we help those who suffer from anxiety feel less anxious on a daily basis with some sort of application?' and thus began our research.

The goal of conducting research was to create a well-defined problem space to build a better understanding of our target population in order to ensure the ubiquitous solution we create has value. In creating the problem space I came to realize that anxiety is one of the most common mental disorders in the United States affecting 40 million adults over the age of eighteen, which is about 18.1% of the population. And of this 18.1%, only 36.9% of people who are diagnosed receive treatment. There are many different types of anxiety including but not limited to, generalized anxiety disorder, panic disorder, social anxiety disorder, specific phobias, obsessive- compulsive disorder, posttraumatic stress disorder, major depressive disorder, and persistent depressive disorder. We decided to target people with generalized anxiety disorder, panic disorder, social anxiety disorder, specific phobias, and posttraumatic stress. After consideration, we realized we should also focus on people with physical disabilities/illnesses whom are

usually also diagnosed with the aforementioned anxiety disorders such as people who underwent or are currently undergoing cancer treatment or disabled war veterans to name a few other potential target markets.

After recognizing potential target markets, we wanted to understand the current resources available for these people and the limitations of these resources. People can seek out various types of therapy, medications such as SSRI, SNRI, and Benzodiazepines, a service dog, or emotional support pet. As mentioned in the beginning of defining the problem space, 63.1% of people with anxiety don't receive any form of treatment, even though there are several options available. This could be in part to the social stigma of going to therapy, or not having insurance that covers therapy or needed medications, or the possibility that some people are nervous about the side effects that come along with medication. As for the emotional support pet, and more specifically the service dog, we discovered that service dogs are very expensive, costing an average of $35,000 in addition to undergoing a long application process that also includes doctor approval. Consequently, owning a service dog is expensive and often not even a viable option for many people even though a service dog's abilities are very beneficial. In analyzing service dogs, we were launched into our second research question 'how can we replicate and improve the abilities of a service dog in an application to create more accessibility?'

In studying service dogs, some of their main roles in aiding a person include providing medication or water during an anxiety attack, providing a phone to call their support system, lead someone to you in a crisis, provide tactile stimulation by licking the face to help manage emotions, and by providing pressure to the chest or abdomen to

create a calming effect during distress. The goal of our system is to recreate this same calming affect that dogs have by implementing the principles of calm technology, meaning that the technology knows when to start and stop providing assistance without constant maintenance.

After concluding our research, our main goal was to create a system that allows for a customizable personal experience as anxiety is an extremely personal disorder and varies greatly from one person to the next. To build the system infrastructure, we needed to plan for the hardware, sensors, software, network, user interface, data collection process, and system handling. Beginning with the hardware, we decided we needed two hardware devices- the smart device and the wearable device. The smart device would either be a tablet or smartphone needed to download the software onto in order to have access to the application. The second component is the wearable to be worn around the wrist. The wearable currently has rubber exterior and the circular head is to be worn on the inside of the wrist. We decided not to include any type of interface on the wearable because our main concern was that if the wearable was something that needed constant attention or even had the option for constant attention, it might induce more anxiety, which counteracts our goals for the system. The wearable will have embedded sensors that include a heart rate monitor, SpO2 monitor, and a stress monitor. These sensors will be used to help predict the risk of a panic or anxiety attacks and through the ideologies of calm technology, step in to help alleviate a person experiencing anxiety. During our research we learned that when people are experiencing high levels of anxiety, their heart rate quickens and when people faint it's because of high levels of anxiety, this is a result of low levels of oxygen in the blood because a person is hyperventilating in which they

release too much carbon dioxide. When heart rate is high, oxygen levels low, and stress high (in any combination or varying degree), the wearable will try help and calm the user by providing haptic feedback in the form of vibration and pulse patterns to try and help the user steady their breathing and heart rate to feel more calm. These pulse patterns are meant to recreate the calming heartbeat of a dog to provide helpful and calming stimulation. Pulse patterns and vibrations can be adjusted in the application, but users are constrained with adjustments because we wouldn't want them to create any settings that could be potentially harmful.

In addition to the hardware, we created software that will be downloaded onto a tablet or smartphone for users to interact with. The goal of the software is for users to be able to keep track of and analyze data collected from the wearable and data inputted manually into the application. In addition, the application will provide feedback and offer guidance to the user. Originally my team decided to provide users the option to set alarms or notifications for medication, however, after some reconsideration, I think this is derailing from my overall view and goal of the app. I think the main goal of the app is to collect data from the sensors in the wearable, provide haptic feedback to keep users calm, and then manage/organize the data that is collected from the wearable and manually inputted in the app for users to analyze and recognize patterns to adjust actions performed during the day to reduce anxiety.

As I mentioned earlier, anxiety is a very personal disorder and treatment varies greatly from person to person. Therefore the goal is to help users recognize trends, patterns, and behaviors to create awareness of certain situations or times when they feel anxious. For example, if the application shows that your heart rate always increases as

you pull into the school parking lot every morning, it may because you are running late and are always worried you won't be able to find a parking space in the lot. This may be an indicator to leave your house a earlier in the morning by adjusting your routine to make sure you don't feel rushed and have more time to safely park. Furthermore, as mentioned during the presentation by an audience member, if an alarm for medication fails to go off, does that hold our software and therefore our company responsible for not properly notifying a person to take their medication, therefore putting them at a health risk? I think there are other alarms in place on smartphones and tablets that the user can make use of outside of our application to alert for medication. As an adjustment, the medication section of the application can be utilized to input manual notes about medication. For example, if you began taking a new medication you might want to track how it makes you feel when you do or do not want to take the medication. However, it is up to the user what manual data they want to collect and how they want to track and interpret their data. In addition to revising the alarms feature, I find it best to remove the chat bot feature. While it could be possible and favorable option to some users, I think it goes beyond the scope and goal of the application. Having a chat bot feature increases the risks of potentially causing harm and negatively impacting the user's well being. Because anxiety is temperamental, meaning that anxiety triggers are constantly changing, it would be difficult, even for an artificially intelligent robot to learn. This is a feature that we would need to ask potential users if they feel comfortable using, and if they do feel comfortable using it, it would have to undergo numerous tests, but even then I see it being high risk for the company.

As for the network, we need to ensure good communication by maintaining connectivity between the hardware and software. The wearable will communicate to the smartphone via Bluetooth signals and the application on the smartphone will update through the Wi-Fi. We also realized in terms of system handling that if the application were to go offline or Bluetooth connection was interrupted, the wearable should still be able to work independent of the software, so it would be able to operate in an offline mode, this is how we would create tolerance for ignorance and transient connections. In an offline mode, the wearable need to have the ability to store the data being collected for a temporary period of time until connection is restored. When connectivity is disrupted, the app will alert the user so they can try to fix the issue. If the wearable were to run out of battery, the application would also alert the user that it needs to be charged. Since we don't want users to receive any unnecessary notifications, we could allow users to customize a haptic feedback vibration/pulse different from their calming pulse pattern to make them aware of a low battery or disrupted connectivity.

Furthermore, we realized certain activities such as exercising increases heart rate, so if the wearable device is unsure about user status and condition, the app will ask users to confirm or deny the activation for the haptic feedback. Another way to combat this issue is to tell the application when you plan on exercising and if exercising patterns are consistent, it will learn that at certain times on certain days the increased heart rate is due to exercise not anxiety. Another possibility, but moving slightly out of the scope of the system, is to enter an "exercise mode" in the application in which the device provides pulses to help a runner maintain pace. (We would need to ask users if they feel this is a beneficially or unnecessary feature.) The other way to combat this issue would be the

lazy way, which we want to avoid, is by the user just removing the wearable during exercise.

We had discussed in emergency situations if sensor readings are at dangerous levels to have the application contact an emergency phone number that you as the user inputted, however, I feel that this goes beyond the scope and the goal of the system and could cause too many liabilities of not alerting people in time or creating false alarms. In the event that there is a total system failure or crash, possible method for data recovery would to have data stored in the cloud. However, data stored would be for a limited time period, I'd say no more than a month, so users could retrieve recent data however longer term data would be lost. The reason we would only store the data for up to the past month is to protect user's privacy. After each month, the data will be deleted from the cloud, but will still be available to users on their application. Then by me saying this, data would have to be stored locally on the smart device, like how pictures are stored in the memory of the smart device, so it is up to the user how they manage their storage on their device.

Therefore, in terms of data collection, I think users trends from previous months wouldn't take up much storage just as data points in visual graphs, but any manually inputted notes would eventually have to be deleted from the app to make room for new notes. That's why we would need to incorporate an option to move this data to another storage of the users own discretion, just like you have the option to move pictures stored on the local memory of your device to a cloud. However, we wouldn't provide this cloud service and a third party would have to get involved. Otherwise users have the option to move the data from previous months to an external drive with more storage. In terms of data collection and the user interface of our application, the data recorded from the

wearable will be saved in the tracker tab of the application and, to reiterate, the users can manually input their own data to express any thoughts about things they experienced throughout the day. We decided not create any feature to directly send the data from the application to a doctor because that could be overbearing and burdensome to them. If all of a doctor's patients used different applications that had different formats, a doctor wouldn't know how to accurately interpret all the information. Therefore, the app is meant for personal use and any concerns or comments you have about the trends and patterns you notice, you can discuss with your doctor at your next appointment.

In continuing to explain the user interface, we wanted to make sure we created an application that prompted a good user experience so while creating the prototype of the app we kept in mind Don Norman's seven fundamental design principles: discoverability, affordances, signifiers, mapping, constraints, feedback, and conceptual model. To achieve simplicity, we maintained well-known actions such as the click to press buttons or action icons, slides to adjust measurements, and the pinch to zoom in for charts. As I mentioned before, I think the alarm tab should be changed to a medication tab to record medication or should just be removed altogether and users can use the journaling section to record medication information. One of the neat features about the journaling section is that instead of typing out your thoughts, the application has voice recognition so you have the option of typing or just speaking. In addition, you can record your feelings through a feelings wheel and then also record additional notes about feelings in this section. We would have to test and determine if users found the "feelings wheel" intuitive or if it should be changed to a vertical or horizontal slider or something else entirely. The tracker section is where you can see the data collected in

tables and graphs to allow users to view and study to recognize trends to better help improve the quality of their daily lives. I think it be a good feature to include a tracker for how many times the wearable was activated to issue calming pulses and vibrations. It's another way to keep track of your anxiety levels. As I mentioned previously, I think it would be best to remove the chat bot and emergency contact system from the application. Maybe these features can be implemented after initial testing with the more essential features of the system.

In understanding how our system is a ubiquitous solution, it is activity based and context aware computing. It is activity based because it tracks activity (heart rate, SpO2, stress monitor) through the wearable device and then records this data correctly identifying which information detected corresponds to each category. As for the context aware aspect, based on physical evidence collected from the sensors, the goal is for the application to detect, or rather be aware, when you are experiencing high levels of anxiety and then to step in and issue calming vibrations or pulses that help to reduce anxiety. Based on the technology's ability to determine context, as the user you can further supplement the context of situations to understand how to treat your anxiety. When the wearable determines an increase in heart rate and activates its calming features, you can add detail by recording you were meeting knew people. This helps you to tag triggers and understand what situations cause anxiety and then take action to reduce anxiety when trying to carry out daily tasks. For further detail about handling the system when context is not determined correctly, please refer to system handling.

To add more detail to protect users privacy, I previously mentioned that data would only be temporarily stored in the cloud (a month's worth of information at a time

before it is deleted) if there is a complete system failure. This is to ensure that nobody has access to your entire medical history regarding your anxiety. In addition, because this is a health-based application, we want to make sure our system is in accordance with HIPPA (health Insurance Portability Accountability Act of 1996) security regulations that protect the users confidentiality and integrity. We don't want users to feel threatened, especially since our users suffer from anxiety and we wouldn't want to induce more anxiety, that their information will be exposed and sold to health companies for research purposes. At the user level we plan to maintain security by password protecting the application, so in order to sign in and view information they need to enter their credentials. Maintaining security and privacy is a big concern of ours since the data is sensitive and we hope to achieve this by meeting and exceeding the expectations of the users.

In conclusion, we hope that our system is of value to those who suffer from anxiety. We tried to develop a system that would be of use to improve their quality of life in which they overcome anxiety to achieve their daily tasks.

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