Convey

Final Project Report

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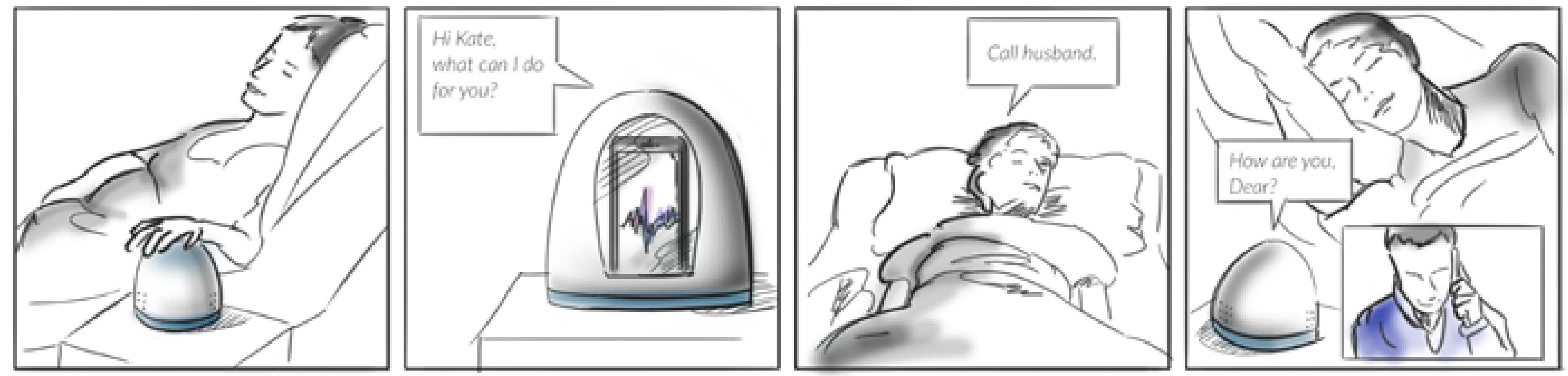
Project Idea

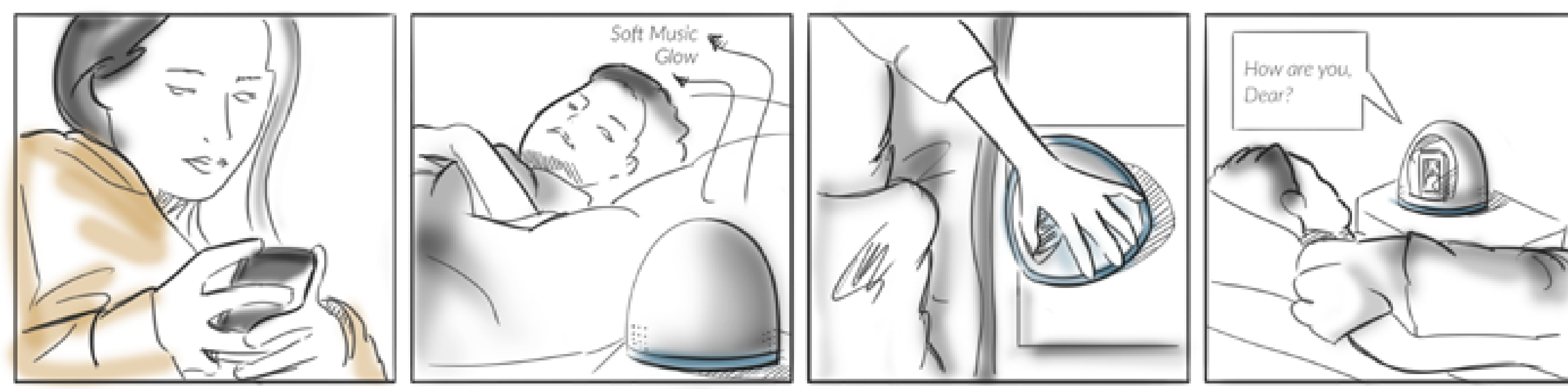
Patients can feel isolated from their loved ones while in the hospital. Nausea, pain, and reduced mobility can all impair their ability to use mobile technology. If the patient has an infectious disease, their cell phones can spread this and infect others.

Convey is a phone dock that helps patients communicate with their loved ones by providing them a form that is easy to touch with a voice controlled interface to make and receive calls. Convey allows users of varying abilities to easily communicate through a simple user interface, touch input, and voice commands. The plastic enclosure of Convey keeps the phone isolated, preventing the spread of bacteria and contagious illnesses. When an incoming call is received, Convey pulsates softly with soothing ambient light.

This project was an extension of our ideation project in the fall, where we generated ideas and explored solutions for a rural pandemic. While our phone dock idea was initially proposed as something that could be used for a patient with Ebola, we saw that it could be applicable to a broader variety of situations, like aiding communication for people with mobility impairments or providing a barrier for less severe contagious illnesses. We wanted to create a testable prototype to see if our idea was a valid approach to this space.



Outgoing call



Incoming Call

Design Goals

We had three main design goals for our prototype:

Accessible

People in the hospital have varying abilities, so we wanted to make the phone dock as accessible as possible so they could easily communicate with their loved ones. We would achieve this by using a simple user interface, touch input, and voice commands.

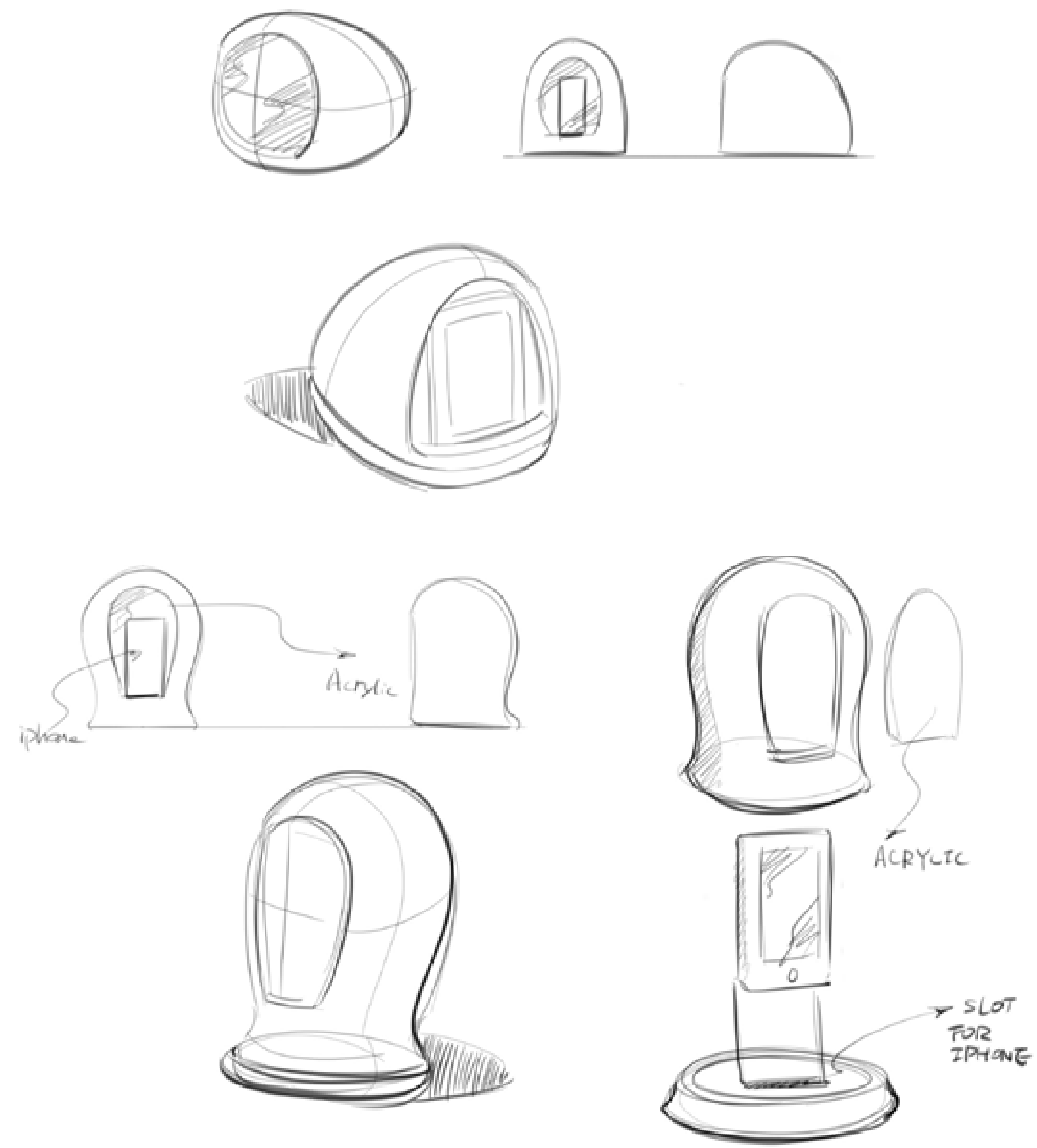
Emotionally Comforting

We wanted to make the phone dock comforting to use for patients who might feel otherwise very sick or weak. We would achieve this by using calming lighting effects that change with the patient's interactions.

Hygienic

The plastic enclosure of Convey keeps the phone isolated, preventing the spread of bacteria and contagious illnesses.

We designed our prototype to test whether touch input and voice commands would be effective and desirable for users. Although a future goal would be to test with actual patients, in this iteration, we focused on first determining whether our prototype could be effectively used to make and receive calls and evaluating our users reactions to the experience.



Process

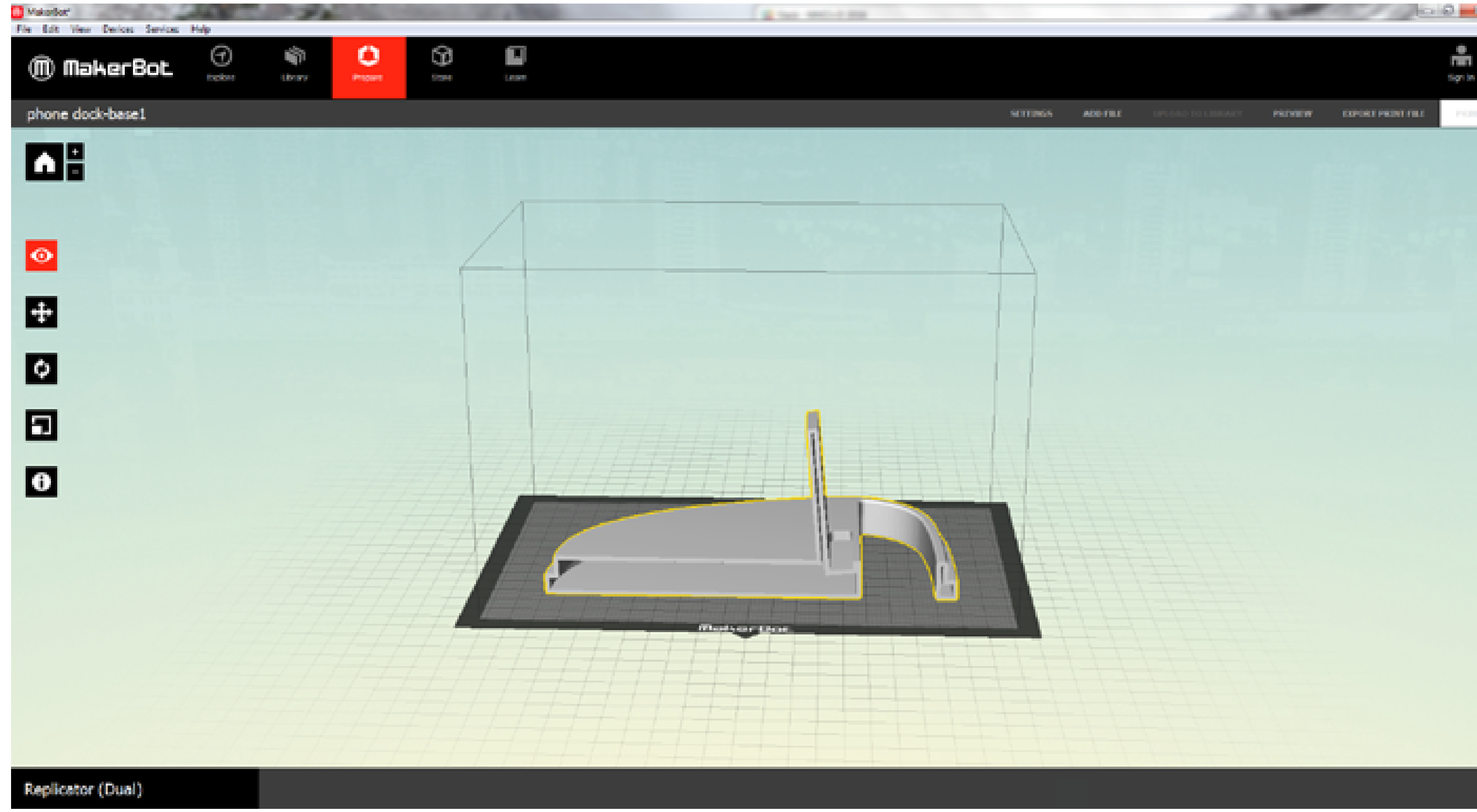
The overall work is divided into three parts in parallel process, which are interface design, physical fabrication and Arduino design. The prototype methods include high-fidelity wireframing, laser cutting, 3D printing, and Arduino. At the very beginning, we had discussion and planning on the physical structure of the prototype, to make sure that electronic elements could fit into the space inside the shell. Overall, it took a week for each member to finish the divided work. After that, we put together our divided work, which involved putting Arduino elements into physical prototype, testing lighting and sound results, loading and syncing interface on iPhone and placing iPhone inside the physical prototype. After the prototype was assembled and functioned well, we moved to the video shooting stage collaboratively and the final video editing and production.

3D Printing

When we decided on building a prototype of our pandemic proposed smartphone dock, we chose to focus on the look and feel of the prototype. As a result, we chose to model our prototype in the 3d space, using 3d printing as a means to allow the user to touch our design. The concept was first developed using SolidWorks, where the 3d model was built. This would allow us to transfer the model into an stl file for Makerbot Desktop, which is the tool we used to print out our model.

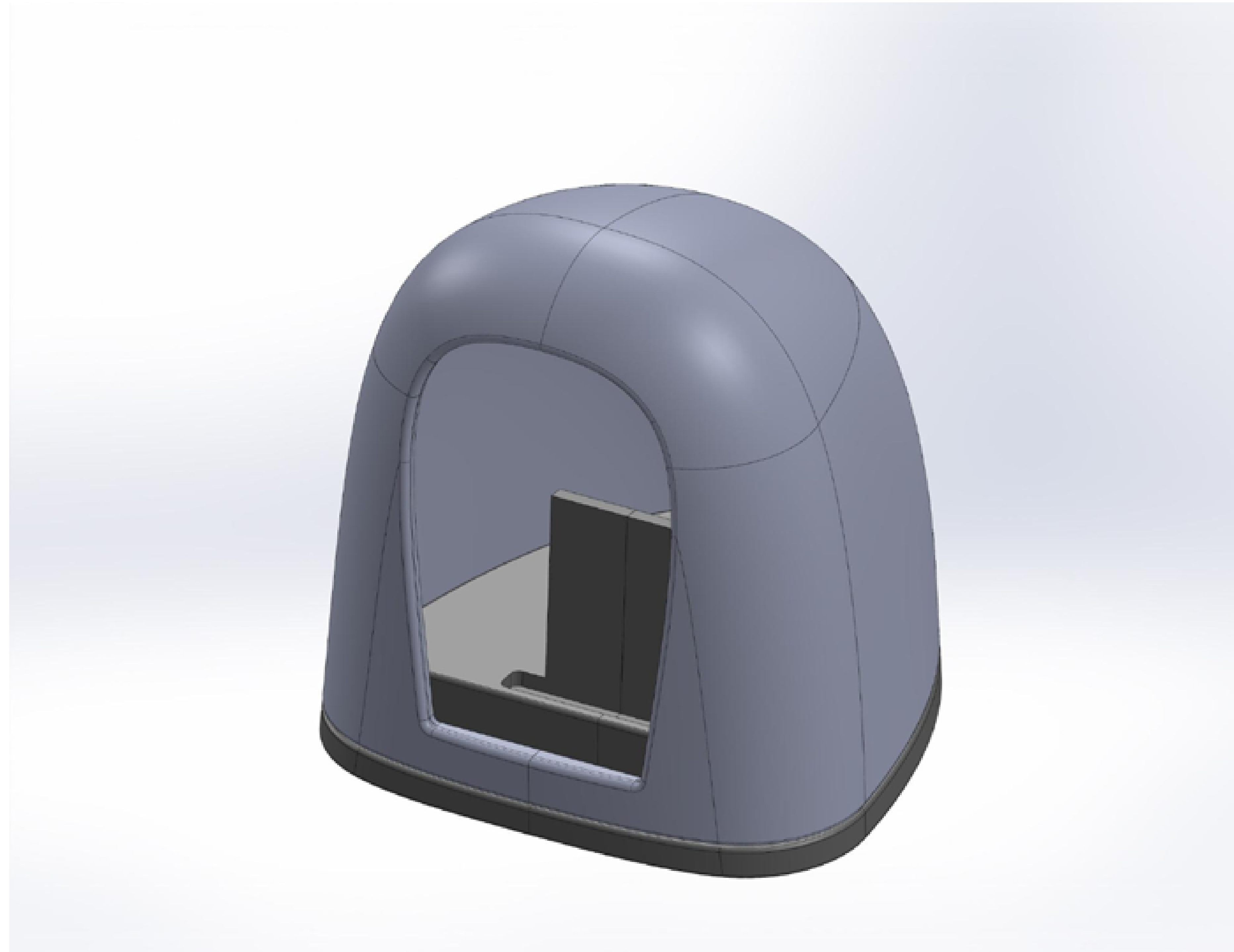
We had to face our first major roadblock when we proceeded to print out the model. Unfortunately the dimensions of the model exceeded the base of the Flashforge Pro 3d Printers that were available. To remedy this, we chose to split the model into 5 parts (2 for the base, 3 for the cover). A final addition to the model would be an acrylic cover, serving as the visible barrier between the user and their phone, which is connecting them to the outside world.

During the printing process, we learned of the many intricacies that 3d printing entails. The layer bed of the printer was uneven at first so the pla wasn't sticking. Then the filament got clogged. However, it was great to see the entire process, especially how the model was built. Even though the preview function in the Makerbot toolkit was cool and provided a very accurate print time estimate, seeing the model being built in front of your eyes, is definitely an eye opening experience for newcomers.



The final result turned out fairly well, as the pieces that were spliced from the original Solidworks model were easy models to print. Because we chose to split the parts into long thin even slices, it was easy for the printer to print each layer since it was flat and parallel to the surface. The total print time ended up being 40 hours (30 hours for the cover, 10 hours for the base) which means it would be difficult to scale up production of this product using this method. This was even after printing at a lower quality (higher layer height and lower infill) to reduce print time.

A possible alternative method for building the prototype could be slipcasting, which could be easily scaled. However, the visual design of the model wouldn’t be the same. Another reason we specifically chose 3d printing, is because you can print translucent models which can allow light from leds to pass through. This was imperative to the overall finish of our prototype, as we had an led strip and blinkm led inside the prototype providing ambient visual feedback through the glow in the translucent plastic.

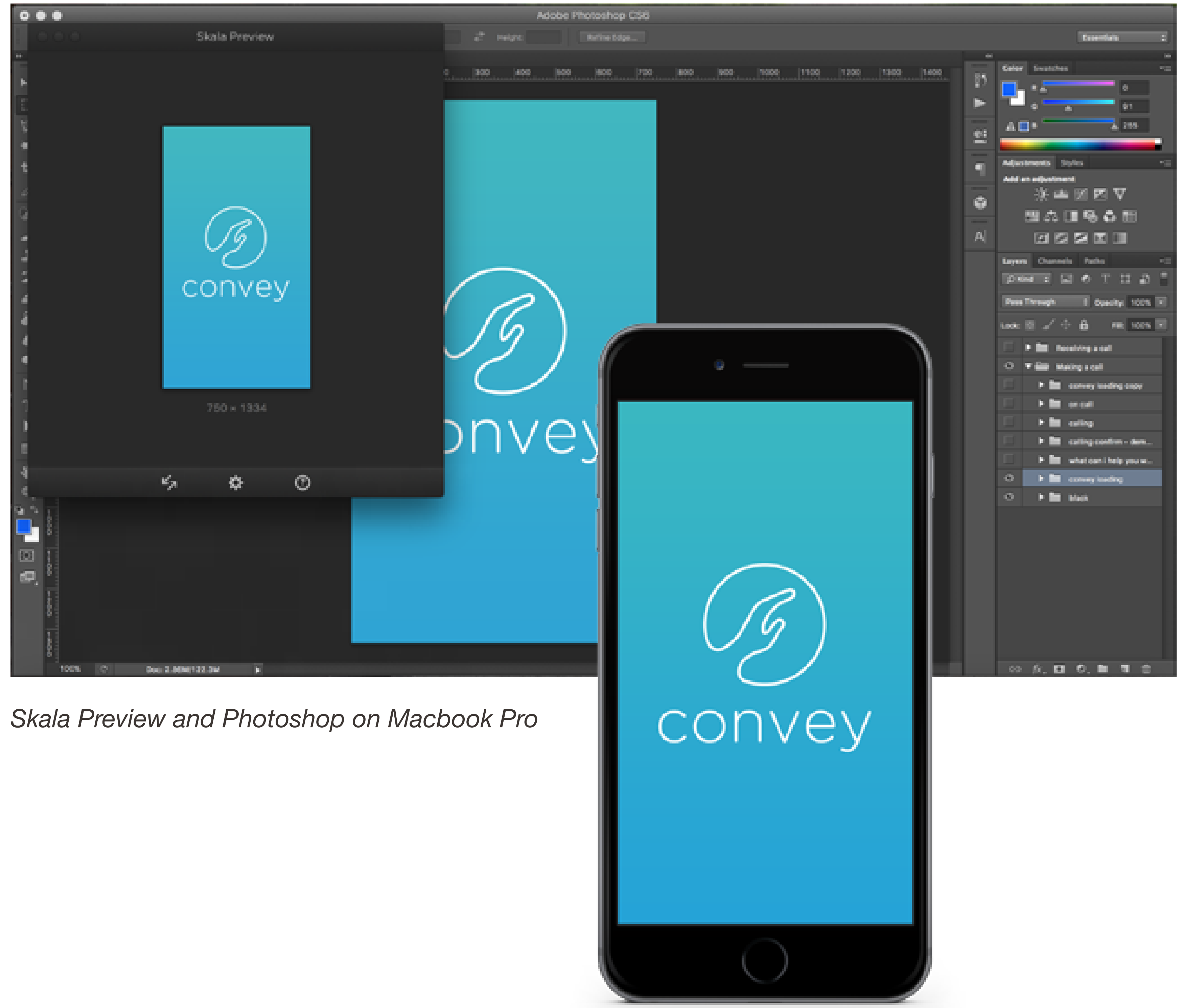


User Interface

We wanted to create a user interface that was easily visible and simple enough to use for someone in bed at a hospital, who might have an illness or motor impairment. In addition to this, we wanted to make something that would complement both voice and touch interactions, making things easier for patients of varying ability who might not be able to easily communicate.

First we looked into whether we could remotely control an iphone from a computer, but there was no easy way to do this. Rather than trying to work within the restrictions of the iPhone software itself, we decided to investigate ways we could simulate a phone call by mirroring a screen to the iPhone.

We first tried an app called Composite, which uses a wireless Internet connection to connect to Photoshop, allowing someone to remotely turn on and off layers to simulate an interactive UI. Although this solution worked, there was a lag of about two seconds. We found an app called Skala which did something similar and had less lag. We installed Skala Preview on a Macbook Pro and Skala View on an iPhone for it to work. While this app let us easily switch between screens, a drawback to this method was we could not use transitions or animations. Neither app would let us connect through the UW network, so we had to create a Wi-fi hotspot on another phone and use that instead.

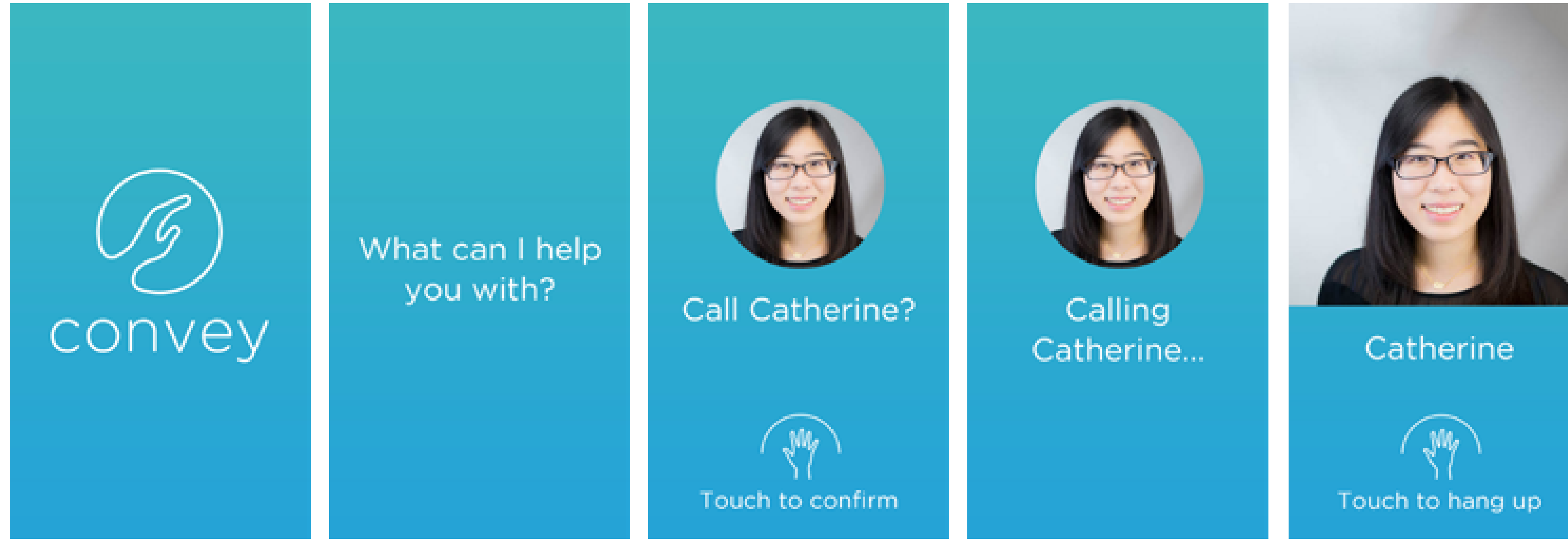


Skala Preview and Photoshop on Macbook Pro

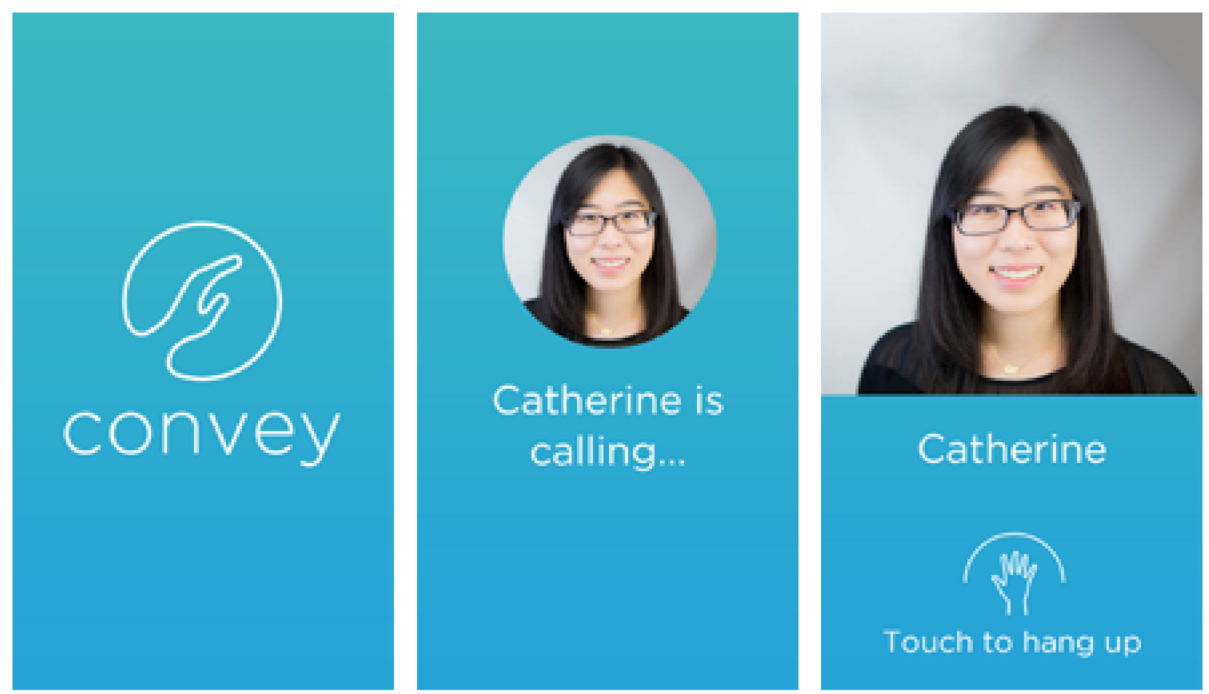
Skala View on iPhone 6s

Sounds presented another challenge for us. After discussing solutions involving Arduino and playing pre-recorded sounds, we decided to simply place a second phone inside the housing with a call already in progress. This allowed us to respond to the user's interactions and provide appropriate sounds in real time.

After exploring all of our options and constraints, we decided to create a user interface simulating an outgoing call and an incoming call. In our design, we used large text and contrast to provide clarity for the user. Simple diagrams aid the user in understanding how the touch interactions work and are large enough for them to view through the acrylic screen. During calls, a comforting image of their loved one is displayed.



Screen sequence for making a call



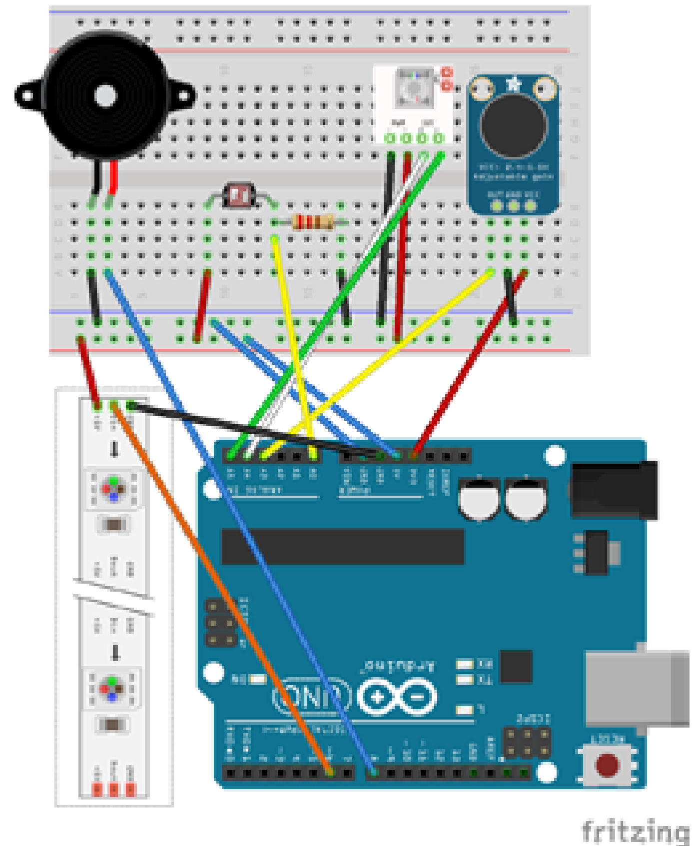
Screen sequence for recieving a call

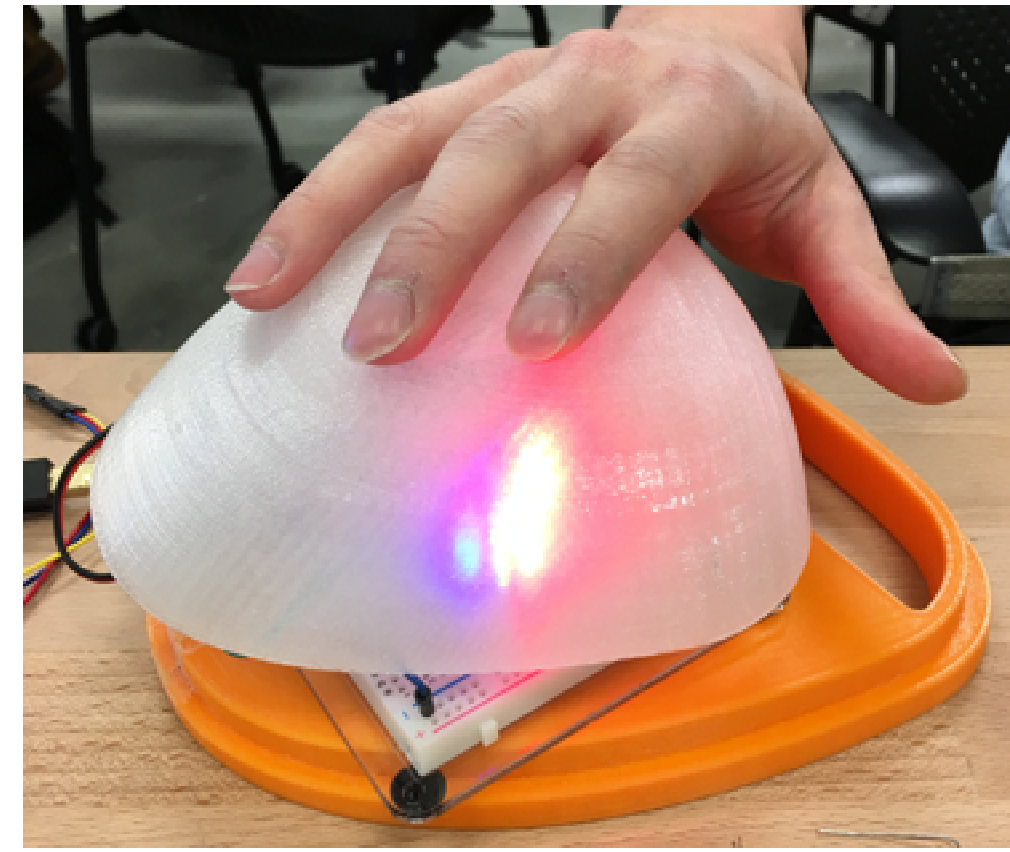
Arduino

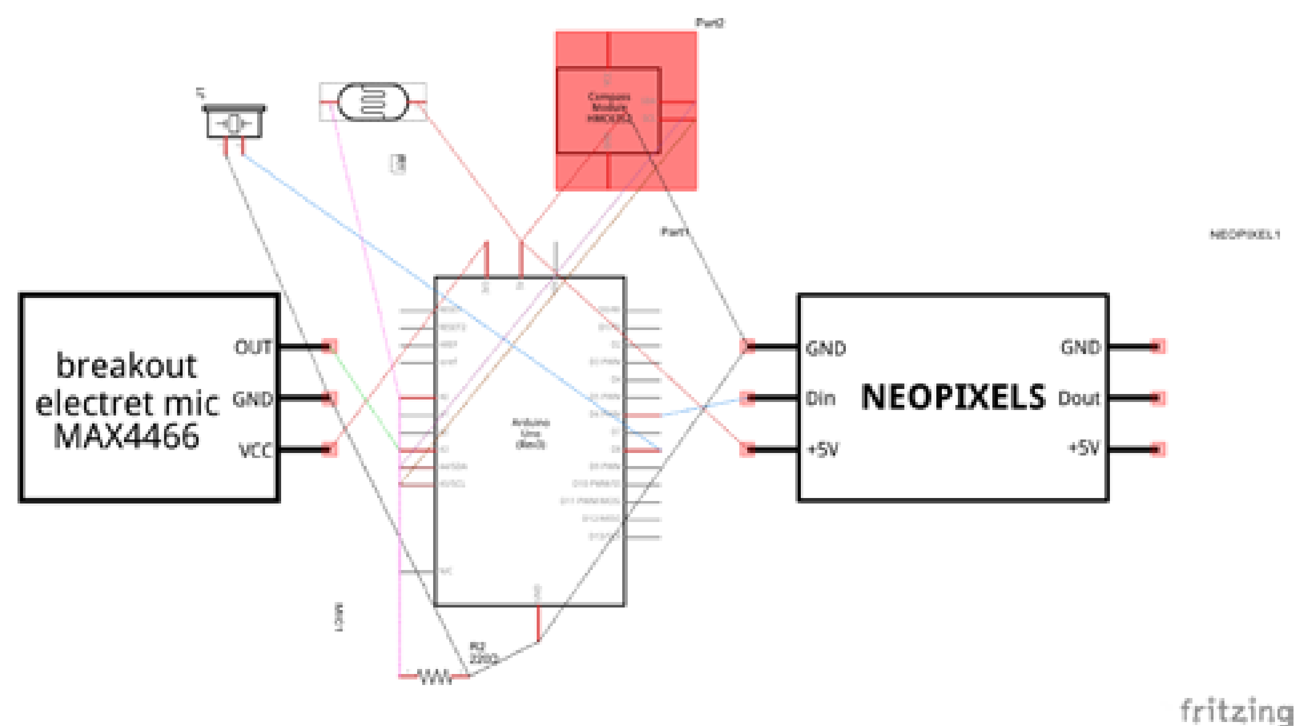
Since the target user of our prototype were patients in a pandemic situation, we wanted our prototype to provide clearly distinguishable states though audio and visual feedback. However, this feedback could not be too strong, as it could prove distracting to the user. We decided to go with leds for visual feedback, while using a buzzer to provide audio feedback.

The next step was deciding on a trigger that detects when a user has touched and activated the device. We played with several possibilities, such as proximity sensors, touch sensors, infrared sensors, and light sensors. In the end, we chose to move forward with the light sensor (ldr), as it provided the most unobtrusive method of detection on the device's end.

If we had chosen to implement the proximity sensor infrared sensor, we would have had to cut a hole at the top of the device, which would detract from the prototype's form. This is because the 3d printed cover is translucent, which reflects and blocks many of the incoming/outgoing waves. This is still an issue with the light sensor, but because it's so sensitive to light, it's still able to detect when a hand is touching the prototype, since it blocks much of the light detected by the sensor. We also refrained from choosing the touch sensor for the same reason of wanting to avoid cutting a hole in the form to embed the sensor. By avoiding this step we were able to stay true to our original goal of keeping the phone completely under quarantine with a complete encasing around it.



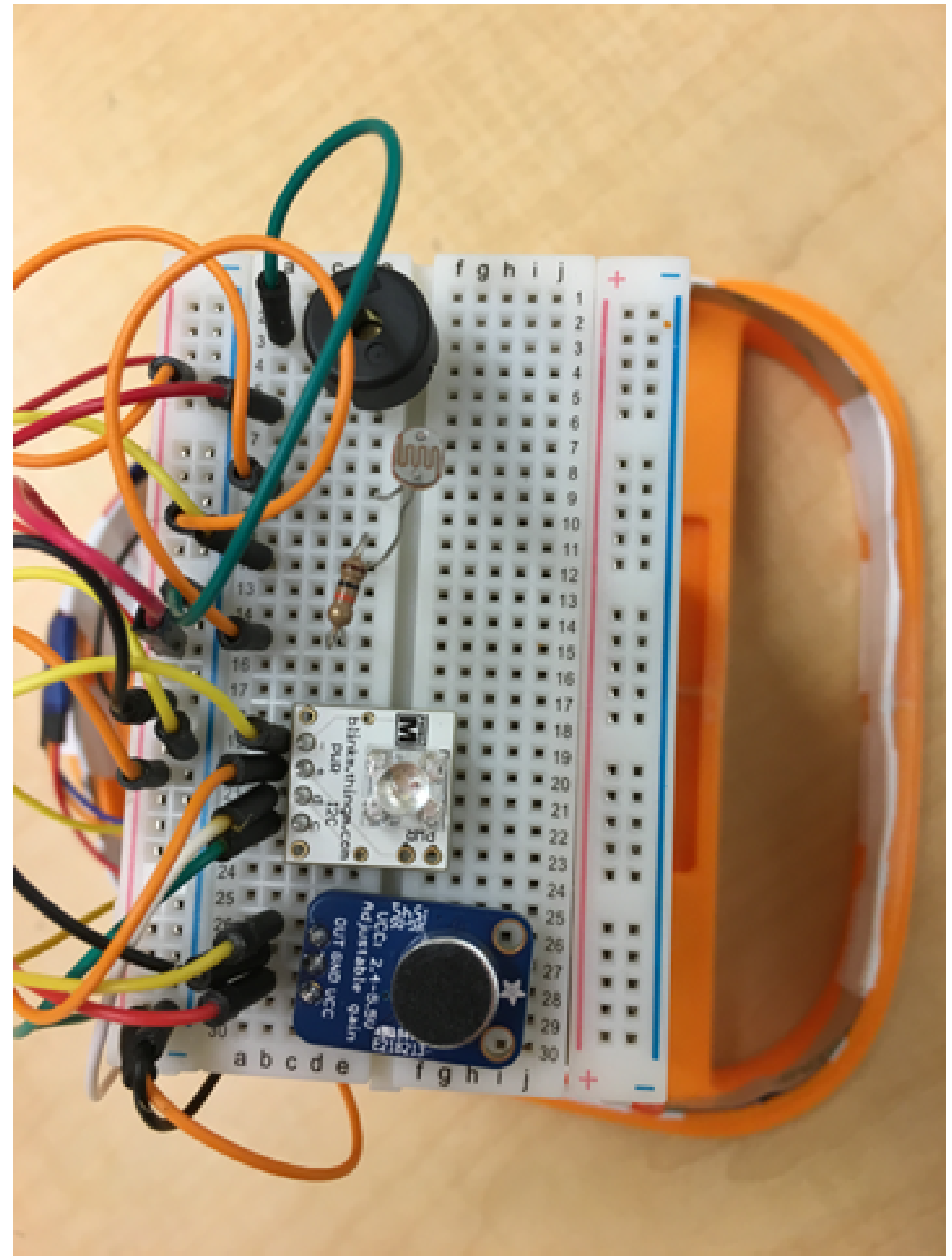




However, we faced several obstacles getting the light sensor working in all situations, since lighting conditions can vary. We resolved this by taking several light readings when the device starts up, and averaging them to determine a baseline and threshold. Then, conditionals were used to determine when to turn on the leds and buzzer, based on the change in light read by the sensor.

Once the sensor was optimized, we worked on the led and audio sequence. We originally planned on only using simple leds, but ran into issues with the led flickering as it transitions between states, since the light sensor readings often fluctuates and the leds are using pwm to adjust brightness. We decided to switch to a blinkm led and Adafruit NeoPixel led strip, which did not have this issue.

For the blinkm led, we had to include the BlinkM_func.h header file, while for the buzzer we had to include pitches.h for the melody playback. The led strip required a header file called Adafruit_NeoPixel.h. The benefit of the BlinkM is that you can load any kind of sequence onto the led using the BlinkM Sequencer tool or through Arduino. However, it's a little more finicky to get running, as you have to remove it before pushing the code, unplug the Arduino, plug the BlinkM back in, and then replug in the Arduino. The NeoPixel led strip also enabled us to have fine-tuned control over each of the 17 leds in the strip. It also came with a built in library that included demo functions that made it easy to specify color and sequence change effects.



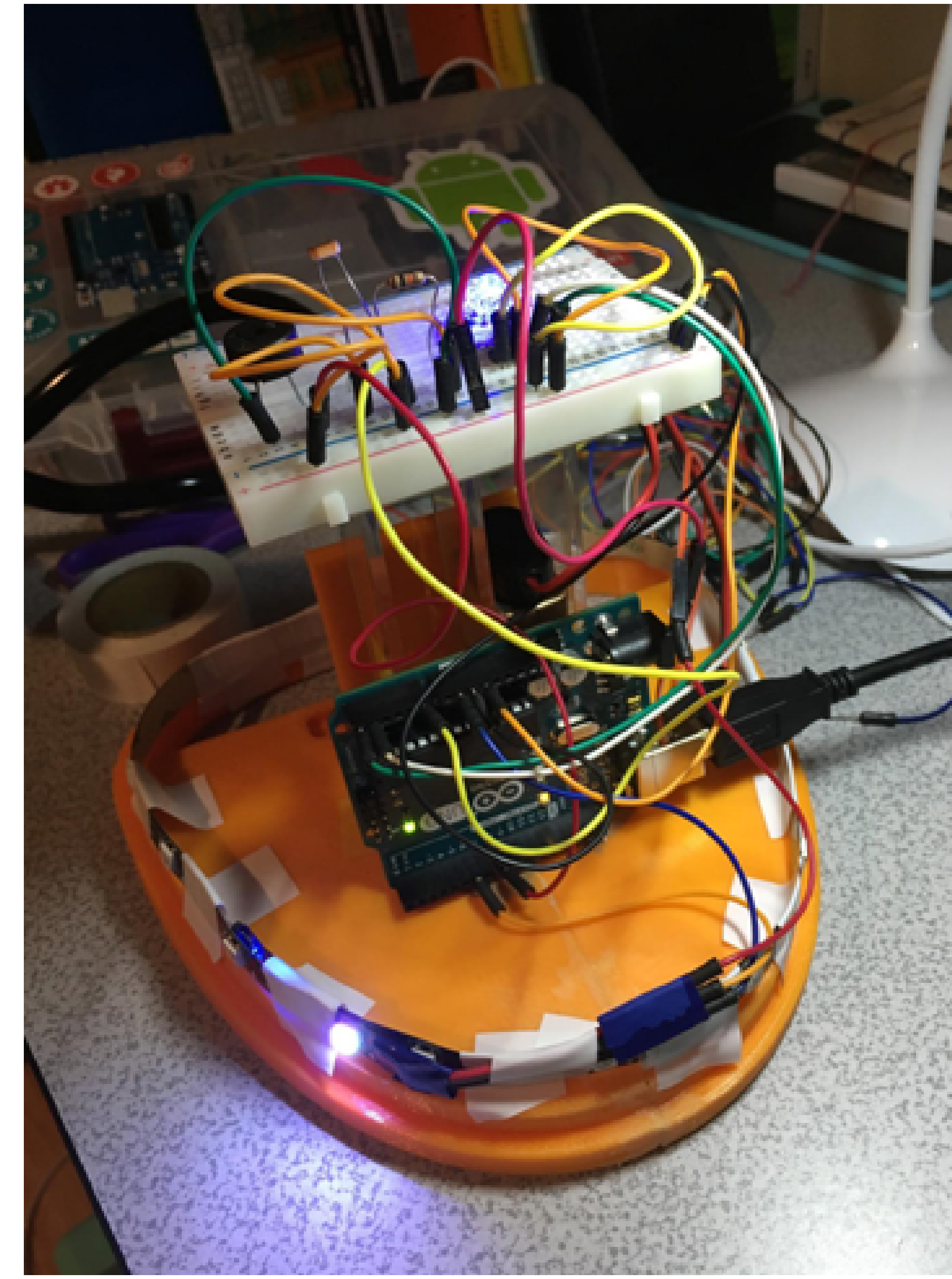
For the led strip, we had to solder the strip to wires connected to the breadboard, as the led strip would wrap around the inner base of the prototype. It would be separated from the breadboard with the light sensor, buzzer, and blink led, which would be located near the top of the prototype. The soldering was extra tricky because we had cut off a piece of the strip that did not start with a pre-soldered joint. When we finally got the solder to adhere, we tested several lighting color schemes and patterns, to determine which sequence would work best with our user interface on the phone.

We ended up with 6 different stages:

- Hand touches shell to wake up device
- Hand is removed and device is awake
- Hand touches shell to initiate call
- Hand removed from shell and call initiated
- Hand touches the shell to hang up
- Hand removed from shell and call terminated. Device goes back to sleep.

Each of these stages was printed out to the serial monitor upon completion of the stage, which enabled us to keep a clear understanding of what stage the arduino was in, for debugging purposes. Additionally, we could tell which stage the device was currently in by the different led feedback that was programmed into the device. Stages 1+2 made the blinkm led and led strip glow blue. Stages 3+4 made the buzzer play a melody, and also made the blinkm led glow purple and the led strip pulsate purple after having some lights chase each other around the circumference of the base twice. Stages 4+5 caused the buzzer to play two short tones, initiated one light chase, then turned off all the leds to reset to the device's original sleeping state.

Lastly, we experimented with incorporating a microphone amp sensor to detect sound levels during the in-call stage of the sequence, and output voltage to the blinkm led based on the volume of sound detected. This would provide an additional piece of visual feedback from the system to the user. However, we ran into complications such as varying baselines as well as the encasing muffling the sound. In the end we decided that this functionality was nonessential to the goal of our device, and set this exploration aside to iterate on in the future.



Video

The storyline of our concept video is based on the storyboard that we created last quarter for the pandemic project. The story is divided into two parts. The first one is the patient initiating phone call with his family and the second part is the patient picking up the call from his family.

The video shooting was conducted in a medical training room on campus in order to mimic the real hospital context in the video. We shot three sets of footage of the whole story from three different angles. One is from the front angle which presents the overall setting of the patient and product. The second angle is more focused on patient's facial expression, and the third angle is the close view of the product attributes and interface. The video is designed in the style of storytelling and product introduction so audience can easily understand the usage and functionality of the product. In terms of video production, the video was composed and edited in Premier and later refined in After Effects.

The most challenging part of the video design is achieving the balance of completeness of storyline and simplicity of the content. The raw footage was shot in large amount and in-depth details, which made it difficult for the final selection and editing. In order to solve that, we added narrative along with the visual story, and it worked out well that the using process was demonstrated very clearly with minimum footage.

Editing the video

Our filming location

Logo

We wanted our logo to embody simplicity and clarity to express the accessibility of our prototype. We designed a simple, rounded image of a hand reaching out and rounded the ends of a sans-serif typeface. The blue color is soothing while still reflecting the hygienic nature of the medical field.

Rendering and Poster

Using V-Ray, we created a realistic rendering of the form and placed it in a hospital setting to create context.

We designed a 24x36 inch poster for our demo to help communicate what our prototype is and how it works, and we modified the rendering to be a header for our poster.

Testing

Throughout our prototyping process, we conducted informal tests with others to gauge the effectiveness of our prototype. The insights we gained by watching people interact with our prototype gave us some direction for our next iteration. People liked the glowing lights in our first iteration, but they wanted to see a stronger visual cue, so we added an LED lighting strip. They also expressed interest in having a ringtone play during an incoming call, so we added that as well.

We evaluated our final prototype by conducting three user tests with strangers. After giving users a brief overview of how Convey works, we gave them instructions for making a call. As the user interacted with the phone dock, we had someone sitting behind a laptop changing the screens accordingly.

Make a Call

- Touch Convey to turn on
- Give a voice command to Call Catherine
- Touch Convey to confirm call
- Talk to Catherine
- Touch Convey to hang up

We then asked each person a short series of questions to learn more about what their thoughts were on the prototype and what they liked and didn't like about the experience. Because we were not able to test with actual patients, we opened with questions about their previous hospital experiences to better frame the interview.

Questions

Have you ever stayed in a hospital for an extended period of time?

What was your experience like?

What, if anything, was easy for you while using Convey?

What, if anything was difficult while using Convey?

What was your favorite thing about the experience?

What was your least favorite thing?

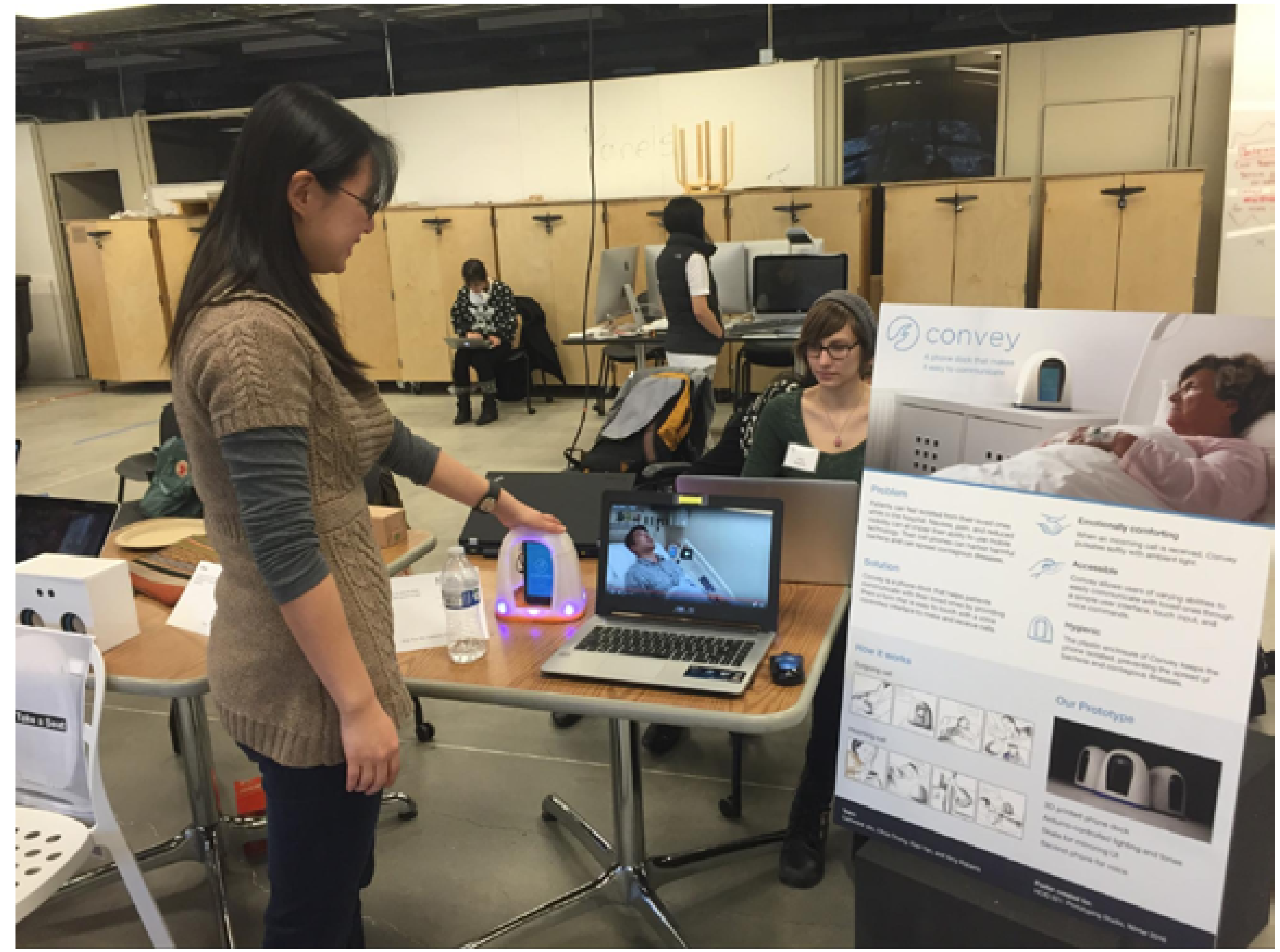
Is there anything that can be improved?

Would you purchase this for yourself or anyone you know?

When we conducted the user tests, the first thing we noticed was that it wasn't always intuitive to the user how to activate the device. This was surprising since the top is the best place for a user to touch the device, as the curves at the top of the prototype conform to a user's hands. The top is also the largest exposed portion of the prototype that a user can interact with, as the front is blocked by an acrylic screen. However, once we explained it to the user afterwards, they were immediately able to get it.

When asked about their overall experience interacting with the prototype, we received generally positive feedback. Many users commented on the form of the device, ranging from how they loved the curved aesthetic, or the visual feedback through the led strip. One suggestion they did make was perhaps to eliminate the touch to confirm when initiating the call. Some users felt this was an unnecessary step if you already have voice control. Unfortunately, due to the limitations of the Arduino, we had to use the user's touch as a trigger to differentiate between states, so that we could translate to the correct sequence when prompted by the user's action. As a result, we would not be able to remove the touch to confirm, unless we also removed the visual and audio feedback from the led and buzzer during this stage.

With regards to the hospital experience, we found that all users had varying levels of experience, yet all shared the same mindset. The users viewed the hospital experience as negative when forced to stay for an extended period of time, due to the isolation from your normal social life. One of the pain points was the hospital environment, which was seen as unfriendly and sometimes artificial, when everything is colored white and you're surrounded by medical equipment. One possibility for improvement was making the experience more personal. Users felt that the Convey prototype was a great way of making a hospital room more personal, without having to make too many changes. The light and sound feedback was a welcome change compared to the normally dull hospital room.



Conclusion

Our prototype was an effective test in demonstrating that a phone dock could be used to easily make and receive calls through voice and touch input. Through our user testing, we found that the form was ergonomic for people to touch and simplicity of the user interface paired with the voice and touch commands made the prototype easy to use.

While our prototype was effective in demonstrating the basic interactions of the phone dock, we would probably need to make an additional iteration integrating real-time voice interactions for a more complete behavioral prototype before moving forward. After making these changes, we could move on to testing our prototype with patients in the hospital.

The next steps would be to conduct more in-depth testing to specifically address each of our design goals: accessible, emotionally comforting, and hygienic. Testing users of varying abilities (motor impairments, weak grip, soft voice, blindness, or another disability) would help us tweak the features to make our prototype easier to use. A diary study would allow us to track and gauge emotional comfort received from the device over a period of time. The hygienic aspect would be the most difficult thing to test, and we would likely have to work with medical professionals on this.

While further testing would reveal more clear design directions, some ideas for future work involve investigating whether UV lights could be used to sanitize the phone dock, integrating a video chat option for a more realistic experience, and adding features for patient entertainment.