FireAway

The New Standard for Fire Prevention, Detection, and Extinguishing Solution for Homeowners

Problem

Throughout the human history, survival from natural disasters and threatening forces has always been an essential need for humans. As our society has progressed and became more technologically advanced, we started to neglect the urgency of survival from fires and other threatening natural forces, as we move on to care about needs higher up on the Maslow's needs hierarchy. Most modern homes may have smoke detectors installed, and occasionally equipped with a fire extinguisher. However, these conventional fire detection mechanisms do not give users complete protection from fire, as they may be unreliable, cumbersome, and requiring much human efforts in order to use. Through our user interviews, we realized that it is difficult for typical homeowners to think rationally and calmly in case of a scary event like fire, and it is dangerous for them to put out a fire by themselves. People with disabilities are the most vulnerable to fires because of their limited ability to move and/or sense. Fire sprinklers, if they are ever installed, cannot effectively extinguish a fire because it is fixed to a limited area and cannot target the fire source directly. We would like to automate and simplify the process of detecting and extinguishing fire to ensure users' safety while preventing loss of users' possessions as much as we can.

Project Background

FireAway is an original, brand new project started by Ty Feng, Anand Sagar, Thiago Tagliari, and Yuanxi Xiu as a class project in a design thinking class at UC Berkeley. The project is sponsored by Dr. Alice Agogino, a mechanical engineering professor at UC Berkeley, who gave the team a design challenge to solve. The design challenge was how might we create new concepts and solutions in "mobile sensing" products/services that meet our target users' needs. We started by brainstorming what are the essential human needs, and we found out safety, fire safety especially, is an all-time human need, yet most current solutions are overly traditional and not built with the user-centric design principles, which means that there are gaps between users' needs and the current reality. As a result, we are researching on how might we meet our users' unmet needs in regards to fire safety, and how might we ensure an innovative and user-centric user experience in preventing, detecting, and extinguishing home fires for homeowners.

Summary of the Process

Our project was divided into five phases (research, analysis, ideate, build and communicate). At first, in our **research** phase we used 1:1 interviews and user observations with the fire department, a disability center and homeowners in Berkeley. After interviews, we used AEIOU chart to organize the data we collected. In the **analysis** we used why-how laddering, 2x2 matrix, and empathy maps to analyse the raw data that we collect from our research. To come up with concepts in the **ideate** phase, we used brainstorming and brainwriting to quickly generate a large number of concepts in a limited time. Using the anti-problem method, we realized the essence of the problems we need to solve, such as awareness of night fire, empowering disabled people, and extinguishing the fire effectively. To choose our top concepts, we used weighted matrix as a decision making tool, and we refined and selected three key ideas to be designed. After selecting the most important ideas to incorporate into our design, we started the **build** phase to prototype our concepts. We started out with rough sketches, then to wireframing, and finally moved to a medium fidelity app. For our hardware, we also started with sketching, then to a low-fidelity prototype made of plastics and cardboards. To get a better idea of what our product would look like in production, we used additive manufacturing to build a 3D printed medium fidelity prototype for our hardware. In the **communicate** phase, we have created a simple interactive game as our version of storyboarding to illustrate a hypothetical fire scenario and to demonstrate how great the user needs are. This interactive storyboard is in the perspective of a representative composite character named Eric that we created from our research. In our design roadmap, we have used our most important quotes to identify needs, and then extrapolate them into our business model.

Process

Research (Problems)

When we selected our topic, we knew fire disaster was a terrifying problem, and we wanted to create a more effective way to reduce both physical and emotional loss from it. During the research phase, we did both **1:1 interviews** and **user observations** to gain insights from users: what are the pain points, what are the gain points, and what are the real needs of our customers/users.

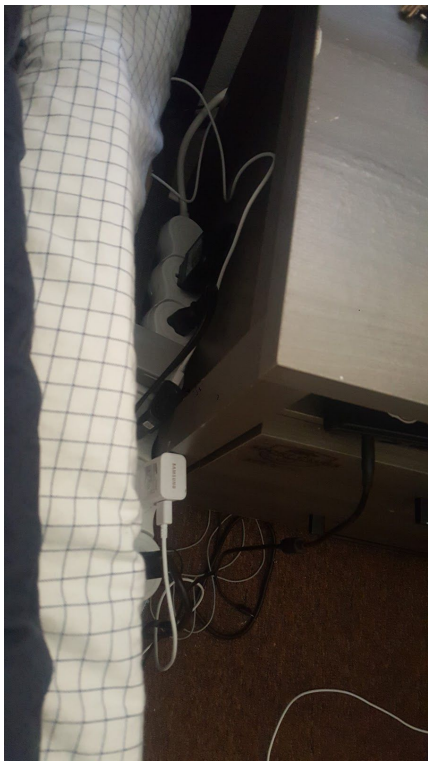
We interviewed the fire department and a disability center in Berkeley, which helped a lot on discovering the problems. The key takeaways from those interviews are:
- sprinklers aren't effective enough because of they don't sprinkle the room evenly
- night fire is the most deadly disaster
- people with disabilities are the most vulnerable

After interviews, we used **AEIOU chart** to organize the data we collected. With AEIOU, we realized that messiness can pose a high risk of catching fire, yet people living in messy houses often don't care about fire prevention that much.

According to all the information from the research phase, we selected our early adopters to be middle to older aged homeowners with high concerns for fire safety and disabled people who live independently.

Ed Roberts Campus, a center for disabled people that we interviewed

User Observation



Overloaded outlets near a bed

Burned dryer in Foothill

Unclean stovetop

AEIOU

A	E	I	O	U
Cooking	Unclean and messy kitchens	Puts flammable things near hot coils or fire	Food scraps, stove, oil	Homeowners, residents, friends
Sleeping	Messy dorms, bedrooms	Plugs in phone and charges overnight, Charges laptop under covers	Power strip, bedsheets, mattress, bed	Residents
Smoking	Enclosed spaces, dorms, outside	Person lights fire to smoke, puts smoking item and hot ashes on desk	Lighter, tobacco, marijuana	Residents, friends
Throwing out trash	Messy homes	Person throws out hot oil and baking remains near flammable paper and cardboard	Recyclables, hot food scraps, flammable trash	Residents, friends

Analysis (Insights)

These are the insights that we learned from analyzing our raw user data, quotes, and observations using three analysis frameworks -- **Why-How Laddering, 2x2 Matrix,** and **Empathy Map**.

We used **Why-How Laddering** to understand the deeper reasons for people wanting to buy our product or service. We found that our users need to be safe in case of fire because they need to hold onto the things and people they have and not have to worry about losing them. They also need to feel more in-control and confident when a stressful and scary event, such as a fire, happens.

Why How Laddering

Why do they need fire safety?

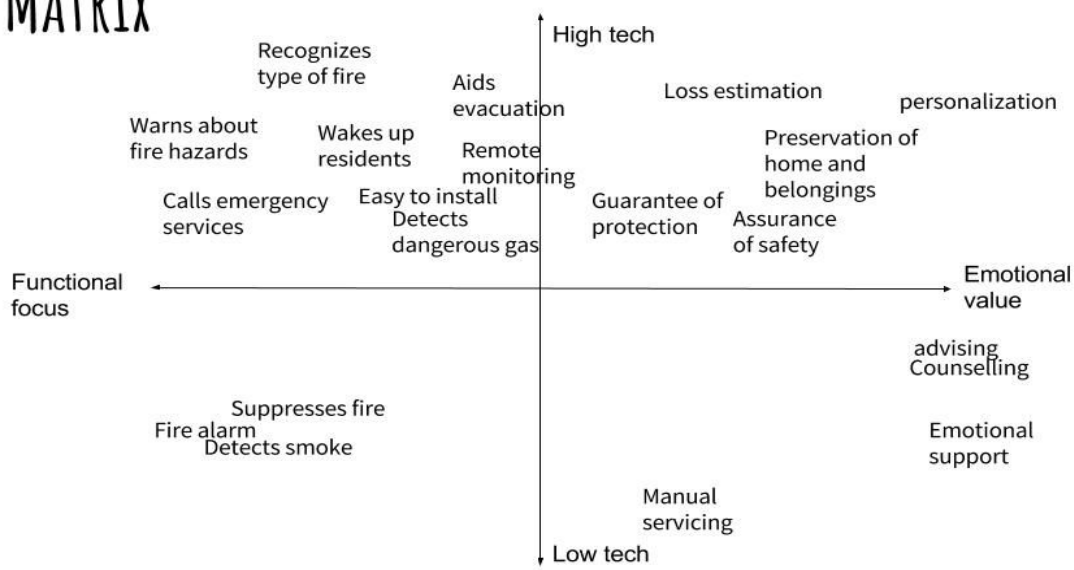
- To protect their own lives → the desire to live, and fear for death → want to have self-fulfilment by achieving life goals, and spend time with people they care
- To protect belongings → sentimental and monetary value → fear of losing
- To have a sense of safety and being in control → to decrease stress and helplessness in case of fire → to have a happy life, free of unnecessary worries or negative emotions

Why is heat detection needed?

- To discern and extinguish fires quickly → to minimize damage to belongings → to save money

We used **2x2 Matrix** to plot out all functionalities and features in a fire-prevention service, and we evaluated them based on functional focus vs. emotional value, and high tech vs. low tech.

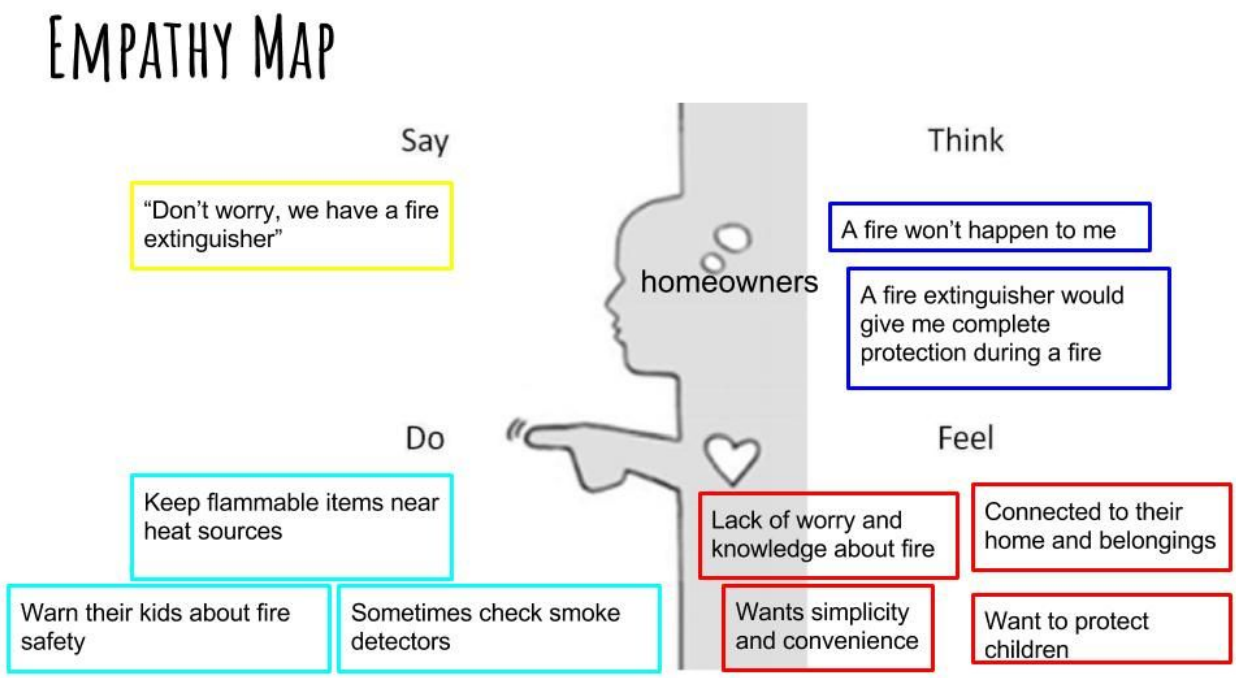
2x2 Matrix

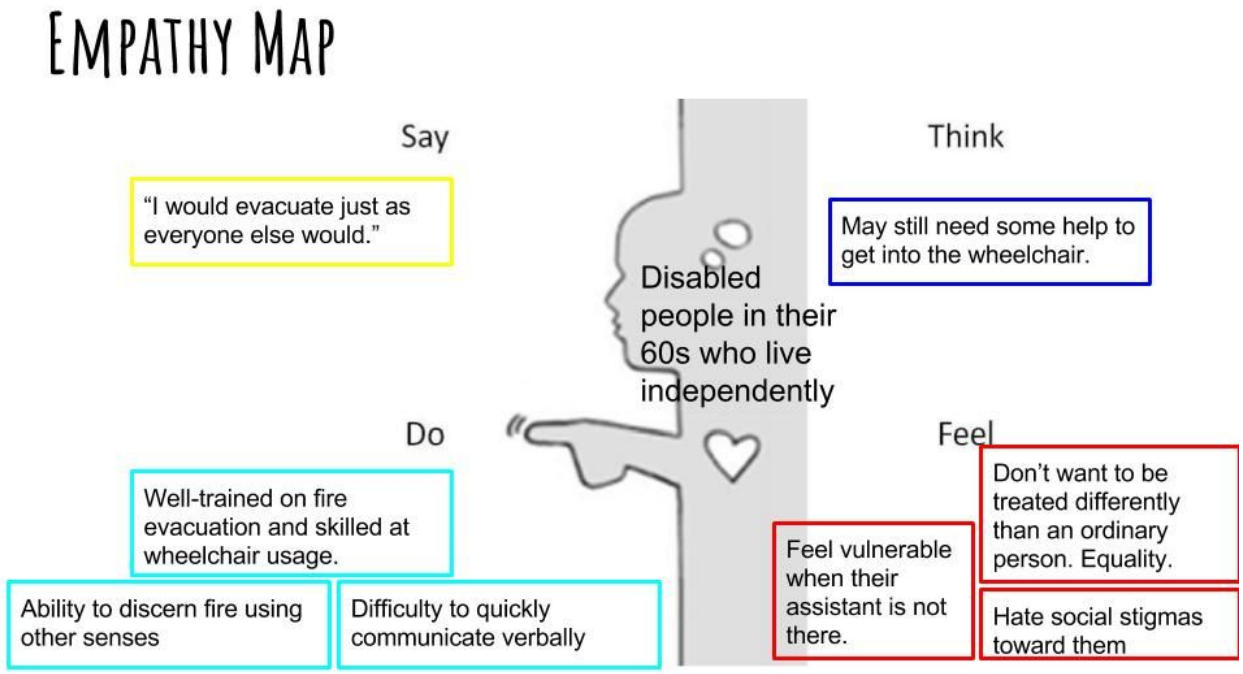


We realized that "home" carries <u>sentimental values</u> to their owners, and the current fire prevention and extinguishing solutions do not address the <u>emotional aspect</u> of the user experience. Emotions like helplessness, panic, and uncertainty would negatively impact users' ability to think logically and to extinguish fire or evacuate successfully. We would like to combine high tech with emotional value to not only effectively prevent and extinguishes

house fire, but to also keep users' emotional needs in mind, creating a more personalized and user-friendly experience.

Finally, we made two **empathy maps** for two different user segments -- one for elderly disabled people who live independently, and the other for typical homeowners. We learned that disabled people need self-esteem and don't want to be treated differently from everyone else, while they still need faster communication methods with emergency services, assistance to get into their wheelchair, and special aids to help them successfully evacuate from their homes. With homeowners, we learned that the typical homeowners don't consider fire safety as their top priorities because they think fires won't happen to them, however, they still have great concerns for home security, especially for their children. In our ideation phase, we came up with a thermal camera that can also be used as a security camera to address the above homeowners' need.



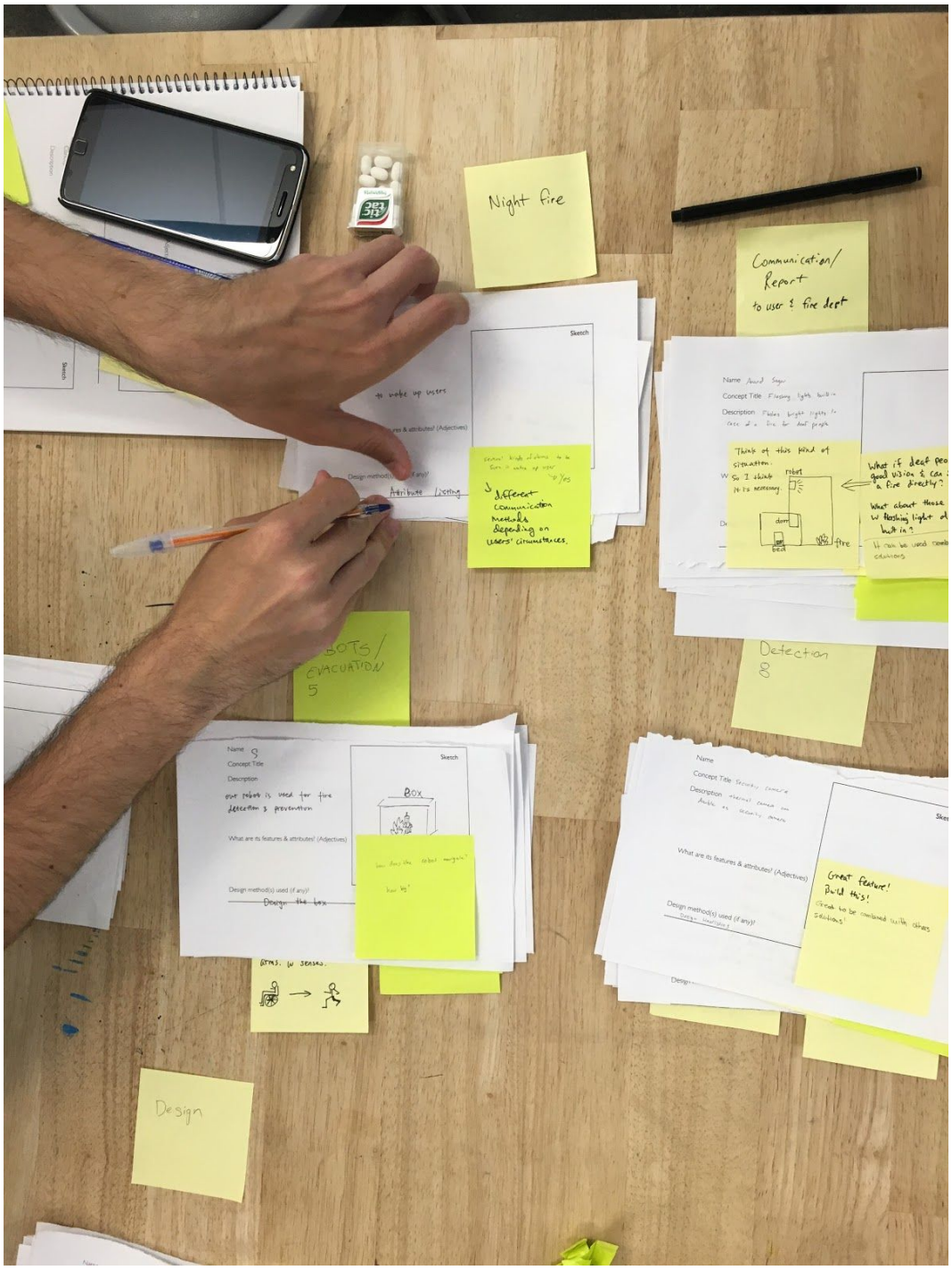


Ideate (Concepts)

Brainstorming & Brainwriting

We needed to come up with ideas as many as possible to understand better how we could address our problem and find solutions. We used **brainstorming** individually and then communicated with each other about the concept we generated using the **brainwriting**

method. With these methods we could get a large number of concepts to refine and develop using other methods.



Brainstorming and brainwriting

Anti-problem
During both individual and group ideation sessions, the most useful tool we found was **anti-problem**. This method allowed us to realize the essence of the problems we need to solve, such as awareness of night fire, empower disabled people, and extinguish the fire efficiently. These insights morphed into innovative concepts later on.

Weighted matrix
With the **weighted matrix** results, we could refine and select the key ideas to be designed. Since we had 7 top concepts, we combined some attributes of those concepts into three concepts. Our final three concepts are a full-time monitoring thermal camera that can scan 360° while using machine learning for sensitivity adjustment; a mobile app that is linked to the camera and sensors, shows lighted/auditory escape route, and sends alarm in case of fire; and a smart sprinkler system that can target fire source.

Team Matrix		Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
User Requirements	Weight	Learned Sensitivity adjustment	Scanning Detection	Sprinkler system	Smartphone compatibility	Lighted/Auditory escape route/alarm	Report Necklace	Portable
Usability	2	4.8	5.0	4.0	4.8	4.5	5.0	4.0
Technology (functionality)	2	4.5	4.3	4.0	5.0	3.8	5.0	1.8
Manufacturability	1	4.0	3.8	4.3	4.8	3.3	4.3	2.8
Potential Cost	2	3.3	3.8	3.0	4.3	3.5	3.5	2.5
Potential of life saving	3	3.0	4.5	4.5	3.8	4.8	5.0	3.3
Potential of fire prevention	3	4.0	4.5	4.3	3.0	2.5	3.3	3.3
		50.0	56.8	52.5	53.0	48.5	56.0	38.8

The weighted matrix we used to select our top concepts

Build (Prototypes)
After selecting the most important ideas to incorporate into our design, we started **prototyping** with sketches on paper. From here, we moved to cardboard, aluminum cans and paper. We asked for input from peers on how to improve the design, functionally and aesthetically and with their suggestions, we modified our design from a rectangular box shape to a hemispherical shape with an adjustable nozzle and built in speakers.

For our companion app, we also went from rough sketching, to **wireframing**, and then to a medium fidelity app that can be clicked through and tested on users.

Following are a list of our ideas that we deemed most important and how we solved each problem.

- Full time monitoring - 360° thermal camera linked to smartphone
- Should not require human input - autonomous with machine learning
- Assists disabled people - voice controls with auditory and visual alarms
- Uses emergency services - built in panic button to call fire department.

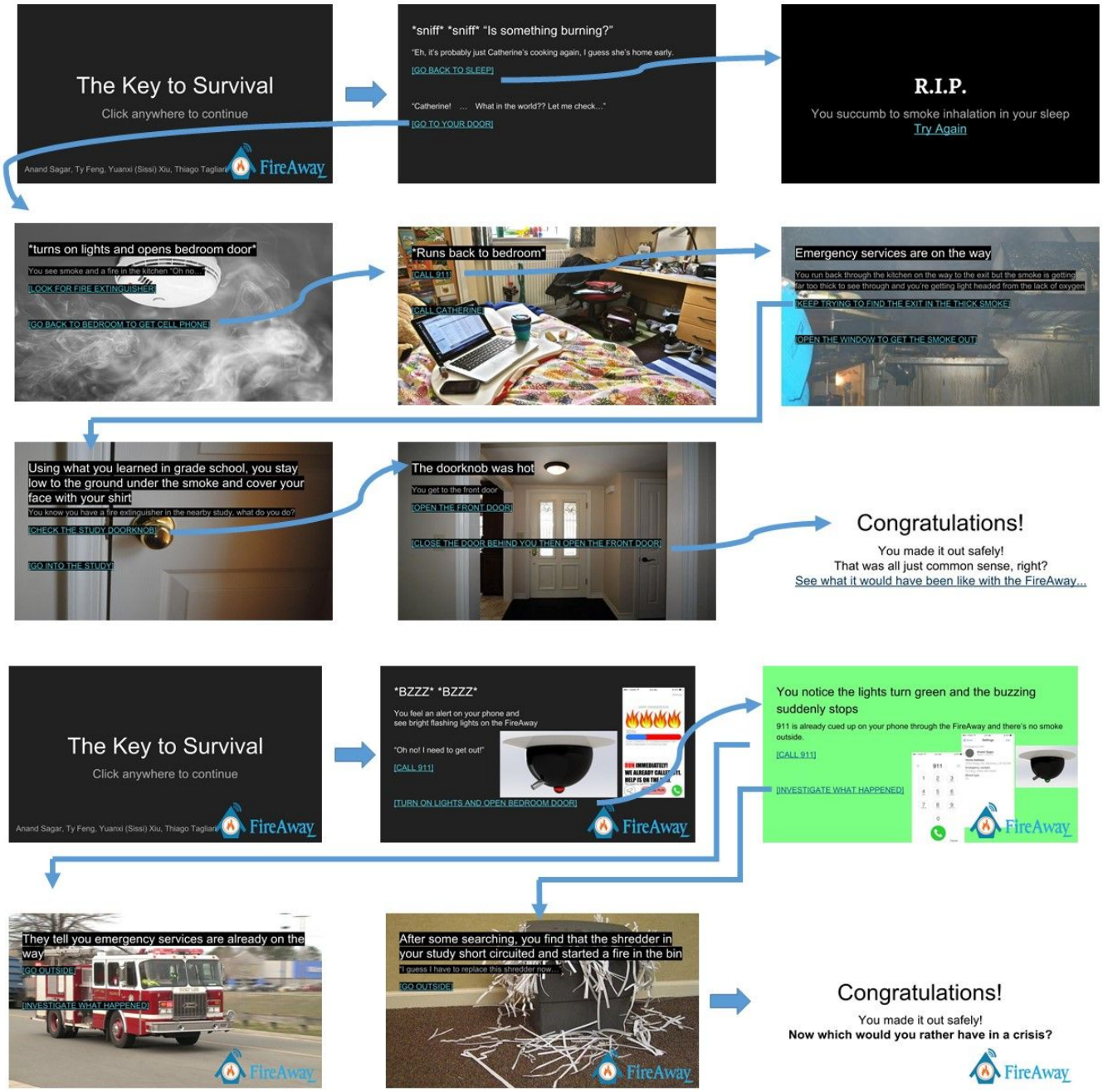
To get a better idea of what our product would look like in production, we used **additive manufacturing** to print out a full scale model which lacks functionality to show investors and users which will allow us to better describe our product and how it differs from others that currently exist.

Communicate (Solutions)

As we are developing our product to a specific group of people, the **composite characters** was useful in identifying the user of our product. This method allows a composite character amalgamates multiple characters, allowing the target audience to be multi-faceted as homeowners concerned about fire and disabled people. Thus, this method helped us to take into account many characteristics of the target audience.

No one wants to read pages of text to understand an idea. That's why we have created a simple interactive game inspired by click-through games as our version of **storyboarding** to illustrate the dangers of fire safety and why our product could save your life. This interactive storyboard is in the perspective of a representative **composite character** named Eric that we created from our research. Eric is a deaf middle aged man who lives in a house with his wife, Catherine. Catherine works the night shift at the local hospital. To see what happens when a fire starts in the middle of the night, play our interactive game and find out. There are scenarios for with and without our product.

As you can see below in our **design roadmap**, we have used our most important quotes to isolate needs, and extrapolate that into a business model. Over time, we plan on expanding our customer base from high risk homeowners to commercial uses as well.



Our storyboard in the form of an interactive game

Retrospective

Overall, our project tended to follow a very linear pattern which means a lot of what could have been done differently connect to that. For instance, after creating the prototype or ideas leading up to the prototype, we could have gone through another interview stage to see how well our users liked the design so far instead of only using peer reviews. We learned that in order to create a very effective design, we need as much feedback as possible in order to cover the situations we don't think of and to get rid of unnecessary features which we thought we needed.

In general, our project worked out quite well with the methods that we chose for each module. Something we could have changed however in relation to it is that we could have gone more in depth into each method. There were times that we only learned what a method was and tried to apply it to our situation which resulted in a shallow usage instead of using the method to its full effectiveness. We also could have iterated back on these methods as well instead of simply doing them once and moving on. Another thing we could have done was modify a method slightly or combine it with another method in order to create a more unique effect. We started to do this in our presentation module with the interactive storyboard and the composite character but we could have done it even earlier starting with the research module. Despite what we did however and what we could have changed, our project worked out well in the end with the feedback from our peers.

Compared to most of the projects we have worked on in the past, this one was far more involved. It required talking to the community to find what was needed and how it could be made. Most other projects only involve one aspect of the process such as the marketing or the physical designing or the coding or even the research but this project was unique in that it did all of them. It saw a product from the birth almost to the selling phase. Because of this however, there were significant time constraints on everything and not everything could be carried out on the level that we wanted.

In the future, the deliverables from this semester could be used to pitch our idea to a company or even directly to our users with a modified version of our presentation. Since we have worked out a large portion of our design, what we would need to do is iterate, build a higher fidelity prototype, test it in a real life environment, and then pitch it to investors. Once the product starts to sell, we could look back on the design chart and try to improve our product for our existing user base as well as try and expand it into more niche areas which could yield higher profits.

Photos of Our Prototypes

Medium fidelity prototype of our hardware:

3D printed using additive manufacturing

Medium fidelity prototype of our app: