Redesigning the Ghost Trap

Final Documentation

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1. Project Description

The problem that we strive to address through this project is of the containment unit where the ghostbusters store the ghosts after trapping them. In the movie, it was shown that the containment unit caused a lot of environmental issues and the EPA intervened to have them shut down. Taking this as our major focus, we introduce a design that eliminates the concept of having a containment unit and we have also redesigned the trap to make it more useful.

Our system design consists of a lotus trap that opens and closes when a switch is pressed. In case of a ghost encounter, the ghostbusters operate a drone with a remote control. The drone carries the trap and drops it at the place of the ghost attack. Once the trap is dropped to the floor, the ghostbusters press another button on the remote control to operate the opening and closing of the trap. When the ghostbusters press the button, the lotus trap opens blinking on yellow LED light. From each petal of the lotus trap, proton beams come out that attack at the ghost based on the location in which the ghost is meanwhile fully opening itself. Once the yellow LED stops blinking and turns solid yellow, it means that the ghost is ready to be captured and a smoky component comes out along with the proton beams emission to trap the ghost. As the ghost is being trapped and when it is fully trapped, the green LED starts to blinking while closing the trap. This signifies that the ghost energy(psycho kinetic energy) is being transformed into renewable and reusable electric energy. This reusable electric energy can then be used for charging our mobile devices.

In this way, our project stands out in a unique way of indicating that the ghost energy can be transformed into reusable energy and also the proton beams emanating from the trap could act as an additional, powerful proton source as opposed to the ghostbusters' proton gun to capture the ghosts. Additionally, we also noticed that in the ghostbusters movie, the trap was not very convenient because of its heavy weight and was very difficult to carry around while the ghostbusters are on the run. So we decided to redesign the trap to be very minimalistic.

2. User Analysis

2.1 Users, their context and environment

For our project, we chose the users to be the Ghostbusters themselves. The ghostbusters are a group of 4 parapsychologists who are mostly experts in particle physics. Their strong understanding of physics (especially particle physics) helps them understand the electromagnetic and radioactive phenomenon related to paranormal activities. This helps them build devices needed to tackle the metaphysical composed bodies. Apart from that, they need to

have good knowledge of paranormal history to understand the origin of different kind of ghosts and how to deal with them in a manner such that it does not cause any harm to the resident or the people involved with the paranormal activity. Due to the unpredictable nature of ghost haunting and odd hours, it is required that they operate round the clock (24/7) and serve the people as and when their help is required.

The place from which they operate has several partitions for various purposes including a storage unit for their gear, suits, vehicle, specialized equipment and, a facility to store and dispose the ghosts that they have trapped on their missions. The vehicle that the ghostbusters use should be able to contain all the equipment they need for their paranormal investigation and elimination.

The Ghostbusters offer their services to the general public which includes people's homes, apartments, as well as business like hotels, restaurants, public and government buildings, etc. Sometimes the buildings are highly hazardous and filthy and since they work in different settings, they have many physical demands which includes constantly running to chase ghosts, going up and down the stairs, driving and most importantly maintaining balance during unstable building conditions. Sometimes they would also have to hand-combat ghosts and defend themselves when they don't have access to their devices. All these demands also require great physical strength and, apart from that they also need to have great reflex and very active senses.

The whole notion of ghost hunting and trapping brings in a feeling of 'uncertainty' and since they deal with different kinds of ghosts of all sizes, shapes, and compositions, the ghostbusters need to wear protective one piece uniforms similar to exterminators. Ghosts can sometimes also throw slime on them to show their aggression and thus they need to have appropriate costumes which prevents the sticky substance from contacting their body and not hinder their movement. They also have protective eye goggles to protect their eyes when the trap disseminates. On their backs they carry their main weapon's power source which is a barrel connected by a flexible tape. The power source very much resembles a leaf blower or vacuum. Their main weapon is used to trap the ghosts and then force them into a ghost trap which will contain them temporarily until they can put them in a more secure container located at their headquarters. Other important equipment includes radio communicators which they can use to communicate with each other while chasing ghosts, and a Psychokinetic Energy Meter which allows them not only to detect whether a ghost in close by but also detect whether a person has been possessed by a ghost. The equipments are hard to control and thus the ghostbusters need to train themselves to use the equipments. The devices themselves are super destructive and can cause major damage and harm to humans ,in certain cases even resulting to death. Sometimes the surroundings can damage their equipment and interrupt their activities.

As they are on the run most of the times as and when their service is requested, it is essential to carry minimum number of things with them so that they are able to service their clients quickly

and can reach their clients within time. In this project, we also plan to focus on this aspect - due to a lot of physical demand in their tasks we intend for our solution to be minimalistic.

Even though the government believes in the ghostbusters, they are still labeled as frauds because if government openly accepts the paranormal activities then it will spread mass hysteria.Thus resulting in people constantly being skeptical about their experiments.

2.2 Tasks Performed by the Users

Within the different environments they often visit for trapping ghosts, the Ghostbusters perform several tasks. These are important because there are many components and variables to each of the tasks that can change to achieve a goal. Each case they take and the ghost that they capture, they encounter unique challenges and difficulties based on the ghost, setting, and circumstances of the paranormal activity. Some of the tasks they perform include but are not limited to:

- Preparing and maintaining their gear and equipment.
- Responding to user inquiries and customers.
- Driving to multiple locations.
- Talking to and interviewing clients.
- Going after and capturing ghosts.
- Disposing ghosts in an non hazardous manner.
- Investigating the paranormal activities
- Develop high - tech weapons to capture ghosts

2.3 Special Needs

Analyzing the difficulties in performing all of these tasks at once at the time of them being requested, it is quite difficult for them to juggle between all these. Hence, we decided to hone in on a solution that would be minimalistic and which would not take up a lot of time for them to carry out. Also, the system should be designed in such a way that the they should be able to easily access it on the go.

3. Feature Analysis

- Lotus ghost trap to capture the ghosts and also convert the psychokinetic energy to electrical energy.

  Design decision: To eliminate the concept of containment unit and the quotient of it being hazardous to the environment by introducing the concept of converting the ghost's energy to reusable energy.

  The trap used by the ghostbusters in the movies was quite heavy and difficult to carry around when the ghostbusters were running round the clock, hence to make it easy to carry around and easily accessible, we decided to redesign the trap. The trap also has provisions to be carried using a handle or it can be easily strapped against their vest - either onto their belts, or on the back of their backpacks. The straps are also situated in such a way that they are easily able to rip it off at their time of need and then easily attach it back once the operation is complete. A USB slot is available on the side view of the trap's base to which a mobile device or a power bank can be connected to with the help of a cable to charge their device portably. The design decision of placing a USB slot came up with the idea that often times since the ghostbuster is on the run, they might forget to charge their mobile devices - which is the most important means of communication with the people they are providing their service with and also a means of contacting them. So we felt that a mechanism in which we convert the ghost energy to reusable energy not having to store the ghost in a containment unit also helps in serving the purpose of charging the ghostbusters' phone. The trap also has a mechanism to hold the converted energy inside the trap until the next ghost attack.

3.1. Guidelines used in designing the Ghost Trap

Our rationale behind each functionality based on Nielsen's Heuristic principles

1. Visibility of System Status

   - The trap slowly opens when it is deployed and ready to trap the ghost. Once, the ghost is trapped, the trap closes itself automatically. The opening and closing of trap clearly indicates its status.

- There are two LED lights on the base to indicate system status. When the trap is changing states, the LED keeps blinking and LED's hold steady when the trap reaches the state. This transition is clearly visible to the ghostbusters.

2. User control and freedom

- Ghostbusters can operate the trap remotely by using a toggle switch. They can open or close the trap whenever they want giving them control over the system.

3. Flexibility and efficiency of use

- Ghostbusters can use the proton beams radiated from the trap to capture the ghost. This provides extra power and saves time.
- Once the ghost is trapped, Ghostbusters don't have to shift the trapped ghosts to the containment unit. The ghost energy is recycled inside the trap itself and converted to clean energy which can be used to charge cell phones.
- Ghostbusters can remotely deploy and operate the trap.

4. Aesthetic and minimalist design

- The trap has a simple mechanism which is easy to understand and operate.
- It simulates the shape of a flower which looks aesthetic as well as the extra proton beams make it highly functional.
- The base has all the functionalities - toggle switch, charging port, and light indicators.

5. Error Prevention

- To make sure that the ghost does not escape from the trap when it is closing itself; as soon as the ghost is trapped, a protective shield locks the ghost inside and the trap closes above it to improve robustness.
- Once the ghost is trapped, its energy is recycled into a clean energy which can be used to charge cell phones. There is an indicator which shows the conversion of energy. Only when the energy is completely converted, the system indicates user to charge the phone. This is to ensure that users plug-in phone only after the energy is recycled.

6. Help and documentation
    - Alongwith a trap there is a manual with clear guidelines to operate it. It also has illustrations to help new users to operate the system.

4. Design Process

We followed a user-centered design process in our product design phase. After recognizing and realizing all the pain points of the user, a basic idea of the product design was sketched out on paper. Firstly, we decided to sketch out ways in which we can make the containment less hazardous and more appealing but then as we delve more deeply into several alternative designs, we felt that the notion of eliminating the whole concept of having to store the ghost would be a possible solution to the problem that we wanted to address.

4.1 Paper sketches

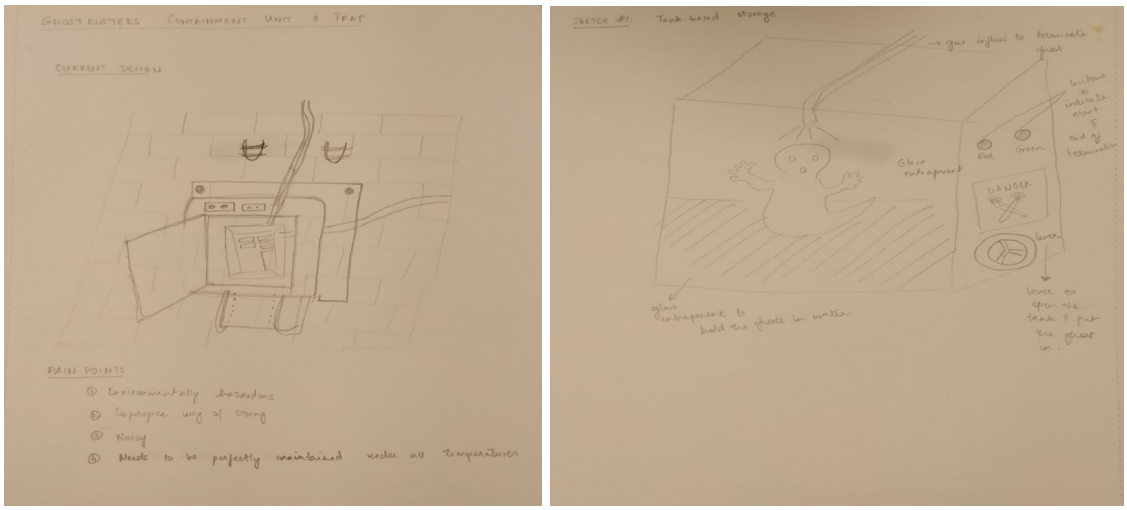

Fig 1. Paper sketches

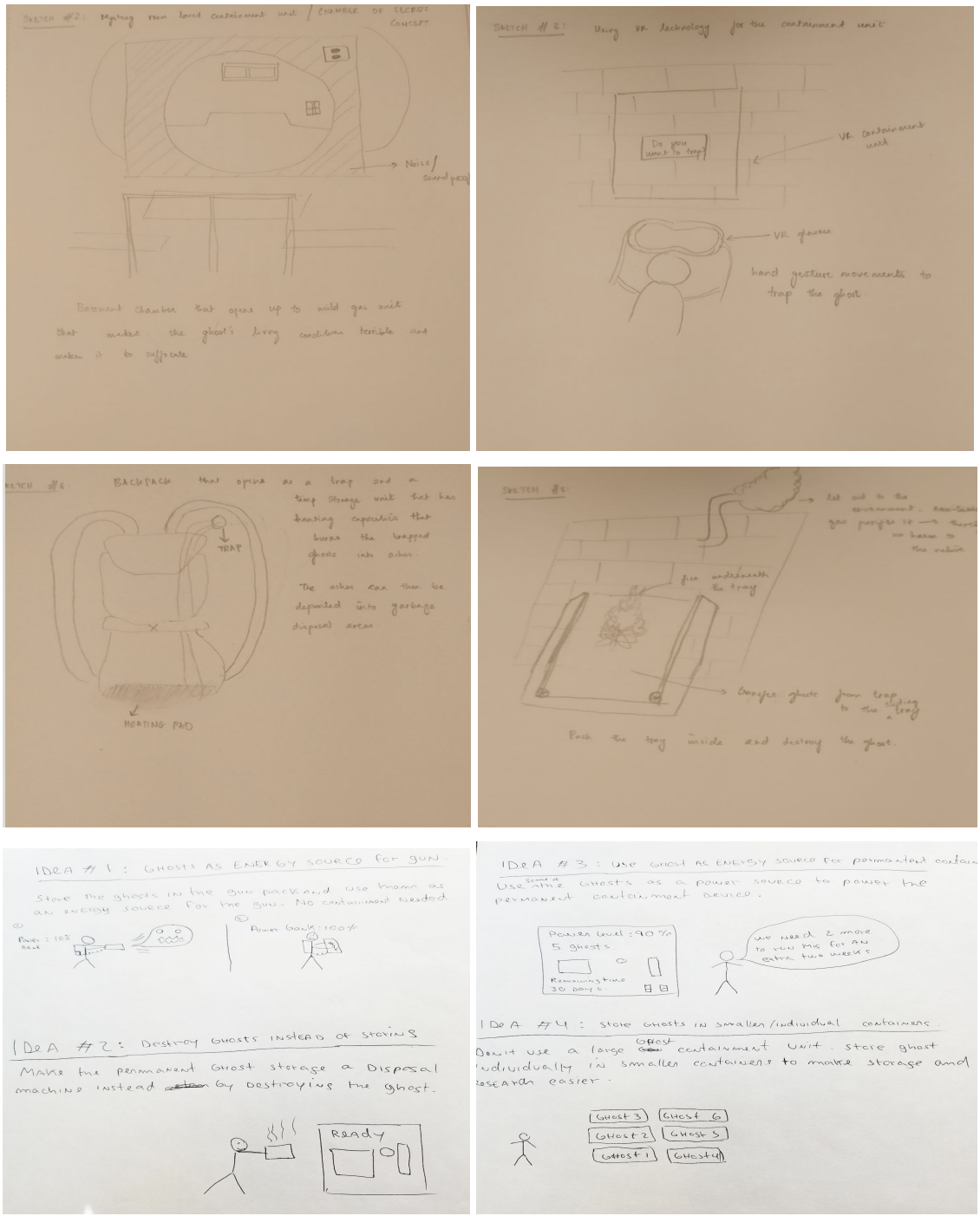

Fig 2. Paper sketches(contd.)

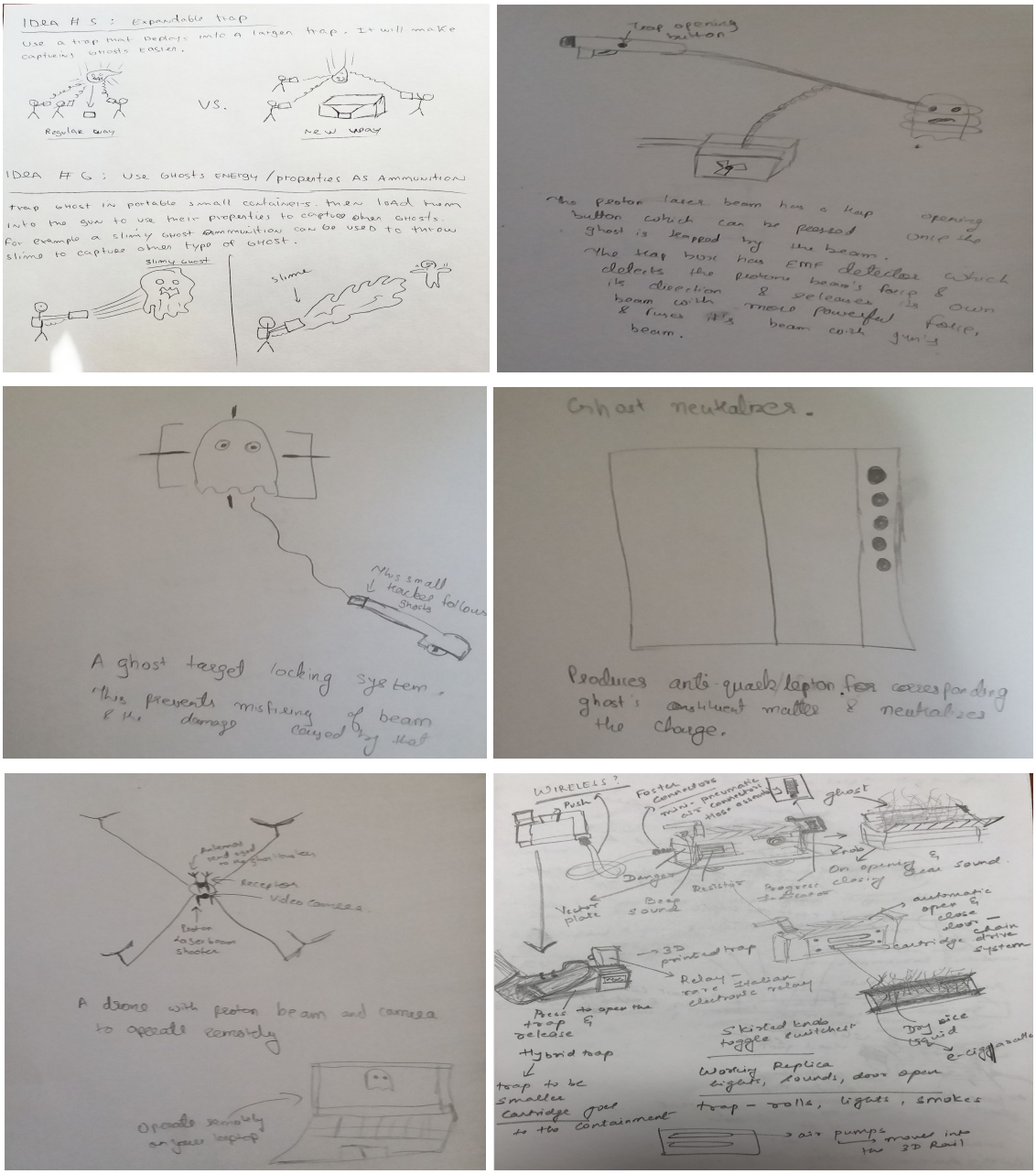

Fig 3. Paper sketches(contd.)

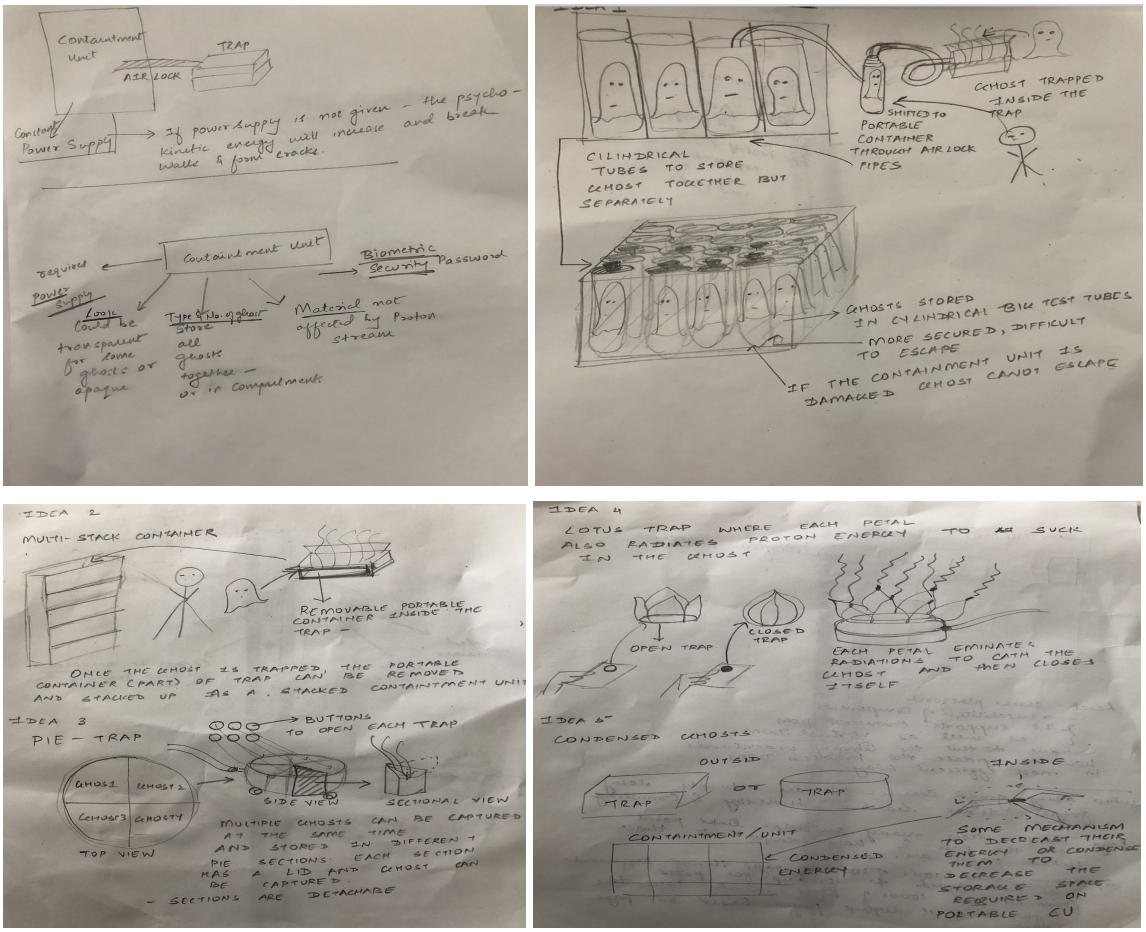

Fig 4. Paper sketches(contd.)

4.2 Low fidelity prototypes

From the sketches that we had, the team discussed on all the possible and viable solutions that would tackle our user's problem. Combining few ideas from the several sketches that we made, we took into account ideas that would benefit a lot for our users and finalized our design idea to be - A lotus ghost trap that captures ghosts and converts ghost energy to reusable electric energy that can be used for charging mobile devices.

Based on the idea that we finalized, we designed and developed low fidelity prototypes to test them with users.

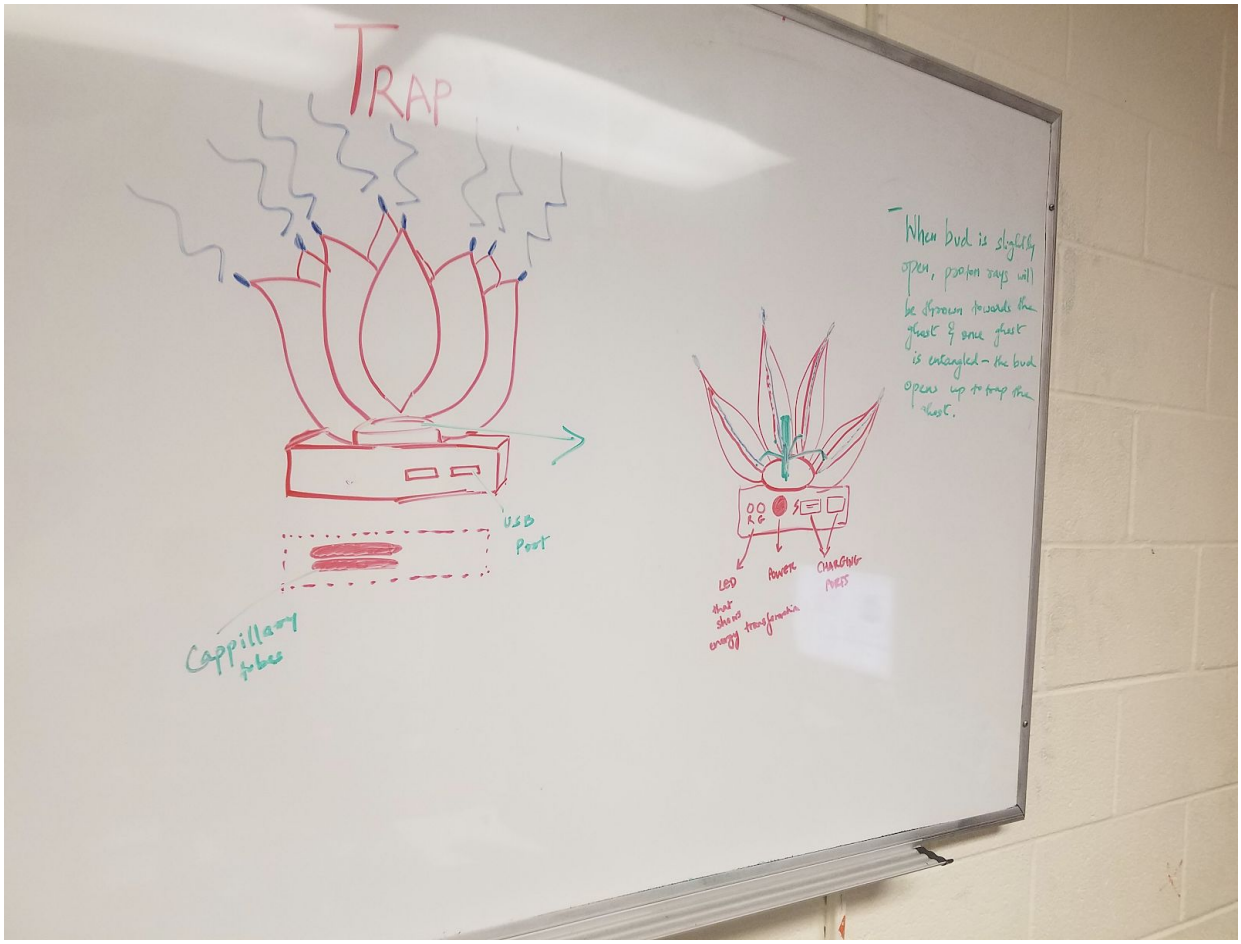

Fig 5. Low Fidelity Prototype

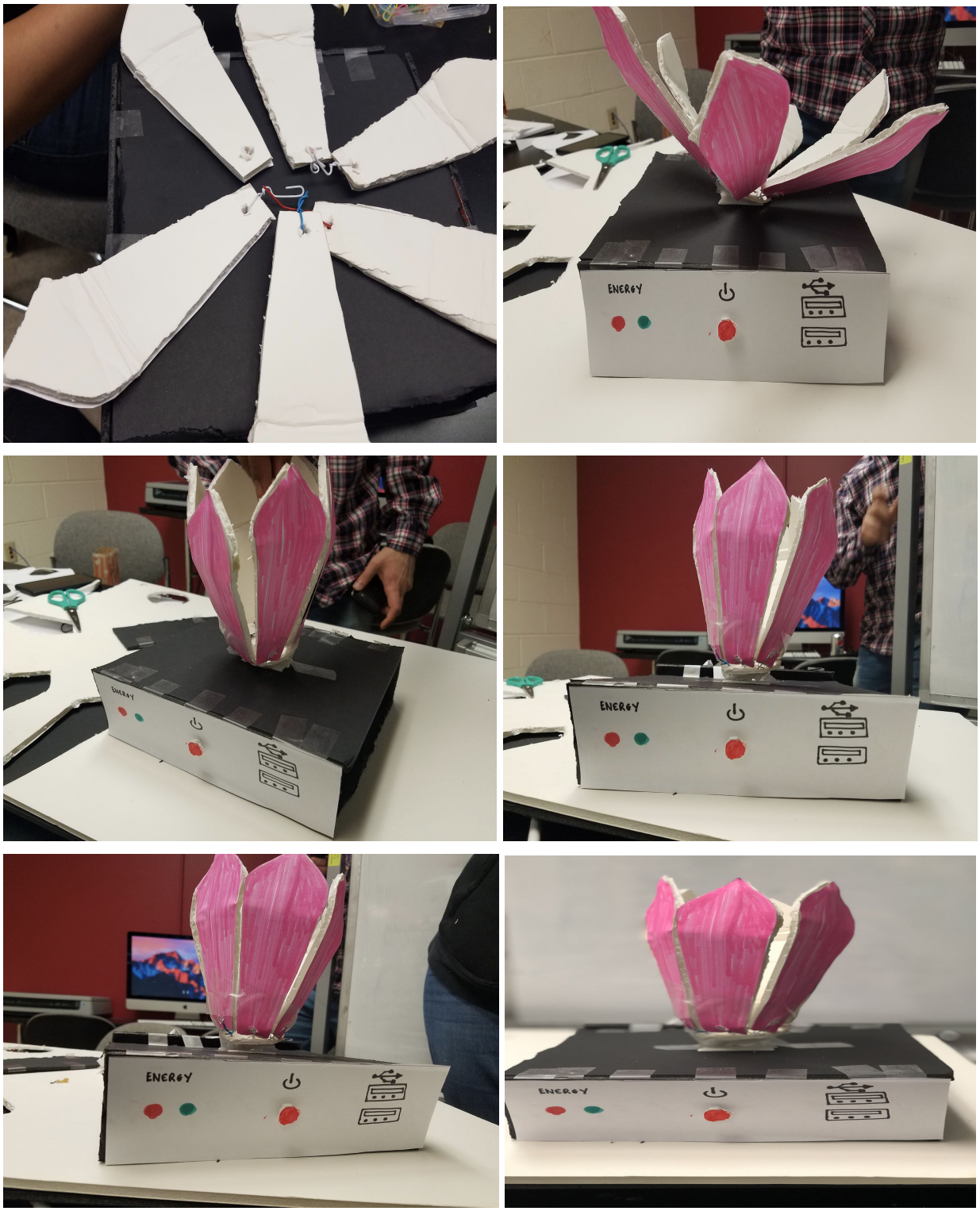

Fig 6. Low Fidelity Prototype(contd.)

4.2.1 Low fidelity prototype evaluation

Heuristic evaluation and usability tests were conducted on the low-fidelity prototype.

The key findings from the heuristic evaluation and the usability tests were -

- The system indicated its status at all times- the functionality of opening and closing of trap was indicated clearly and was visible to the user.
- The low-fidelity prototype was minimalistic and aesthetically pleasing to look at. The prototype had just the minimal required features to be able to use it efficiently in emergency situations.
- Overall, the design provides flexibility and it is unobtrusive. The ghostbusters can operate the trap remotely without any intervention with the trap.

4.2.2 Design changes to be incorporated in the high-fidelity prototype

We received valuable feedback from the usability tests and heuristic evaluation. Some of the major design changes that we needed to make are -

- Need to find a better way to indicate the status of the system as well as the stage where the system is converting the ghost energy to renewable energy.
- Incorporate a mechanism to prevent ghosts from escaping the trap.
- Incorporating a better way to bring out powerful proton beams from the trap such that they attack in the direction of the ghost by detecting the ghost's location from time to time.

4.3 High fidelity prototypes

From the feedback that we received from the usability tests and heuristic evaluation, we tried accommodating the major design challenges that we faced.

Fig 7. Low Fidelity Prototype(contd.)

Fig 8. Low Fidelity Prototype(contd.)

4.3.1 High fidelity prototypes evaluation

A comprehensive in-class user evaluation and demonstration of the prototype was conducted.

System Strengths:

- Visibility of System status: The users were easily able to recognize the status of the system at all stages(opening of trap, closing of trap and while converting energy).

- Minimalistic and Aesthetic Design:
    - The trap has a simple mechanism which is easy to understand and operate.
    - It simulates the shape of a flower which looks aesthetic as well as the extra proton beams make it highly functional.

- Flexibility and Efficiency of use: The system had all the minimal required features that could be put to use efficiently to solve the users problem. The system is also unobtrusive and flexible.

System Weaknesses:

- The system did not have a handle to carry the trap. On asking the users what kind of handles they would like, they mentioned ones similar to suitcases or straps that could be attached to their belts or vests.

- The users found it difficult to understand what the colored LED lights indicated. They felt that the yellow and the green lights contradicted and that the green light should be

emitted when the trap opens and not when the trap closes. Our primary thought into these LEDs lights was that the green light would signify that the ghost energy has been converted successfully and is ready for plugging-in a mobile device for charging it.
- Some of the users also felt that the LED indications could be available at the top of the base as well for quicker response to what stage the system is it. This would be an addition to the already available slots on the side view of the base.

4.3.2 Suggestions provided on the high fidelity prototype

The following suggestions were provided by the users on evaluating our ghost trap -

- *Cosmetic*: It would be great if we could decorate the trap to give a ghostbusters kind of feeling(like add the logo of the ghostbusters and decorate it using diagonal stripes) to indicate that this is a prop that a ghostbuster uses.

- *Visibility*: Addition of the LED slots on the top view of the base as well as it can be viewed only from one side as of now.

- A better way to handle or carry the trap: Straps can be added to the trap so that they can be easily attached to the vests/backpack/belts and can also be easily ripped off when needed.

- Interchanging the colors of the LED to match the real world - making the green color to be emitted while the trap is being opened.

4.4 Final Design

Based on the feedback that we received on the high-fidelity prototype, we incorporated them in our final design.

The changes we made to the final design are -
- We added slots for the LED on the top view of the base for easier identification.

- Since the trap's opening and closing movements took a lot of time, we increased the speed of the stepper motor using a powerful 9V battery.

- We have also added straps on the backside of the base so that it can be easily attached to the backpack/vest/belt and ripped off easily as well.

- To make the trap look like a ghostbusters' prop, we added branding images and the ghostbusters logo to it.

4.5 Technology and Materials Used

1. **3D printed designs for the model of the trap** - the lotus shaped top piece, the base and other components of the trap were 3D printed to give the look and feel of a realistic trap.

2. **Arduino and Stepper motor** - Arduino coupled with the stepper motor was programmed to control the opening and closing of the trap.

3. **LED lights** - LED lights were used to indicate status of the system (opening of trap, conversion of ghost energy to renewable energy and, closing of trap)

4. **USB slot** - to charge mobile devices.

4.6 System Flow

Firstly, in case of a ghost attack, a member of the general public contacts the ghostbuster for their service. The ghostbuster then operates the drone to the location using a remote control. The drone also carries the trap which will be dropped off at the location of the ghost attack. Using a switch in the same remote control, the trap is opened. When the trap is fully opened, it emits out proton beams that attacks the ghost and drains out the ghost. Eventually, after several minutes, the ghost is trapped into the ghost trap and the trap closes slowly but steadily. In order to conceal the ghost and not let it to escape, a protective shield available inside the trap locks the ghosts. During the closing of the trap, the ghost energy is converted to renewable energy. Once the trap is fully closed and a green LED lights up, it signifies that the trap can now act as a power source that helps the ghostbusters to charge their mobile devices.

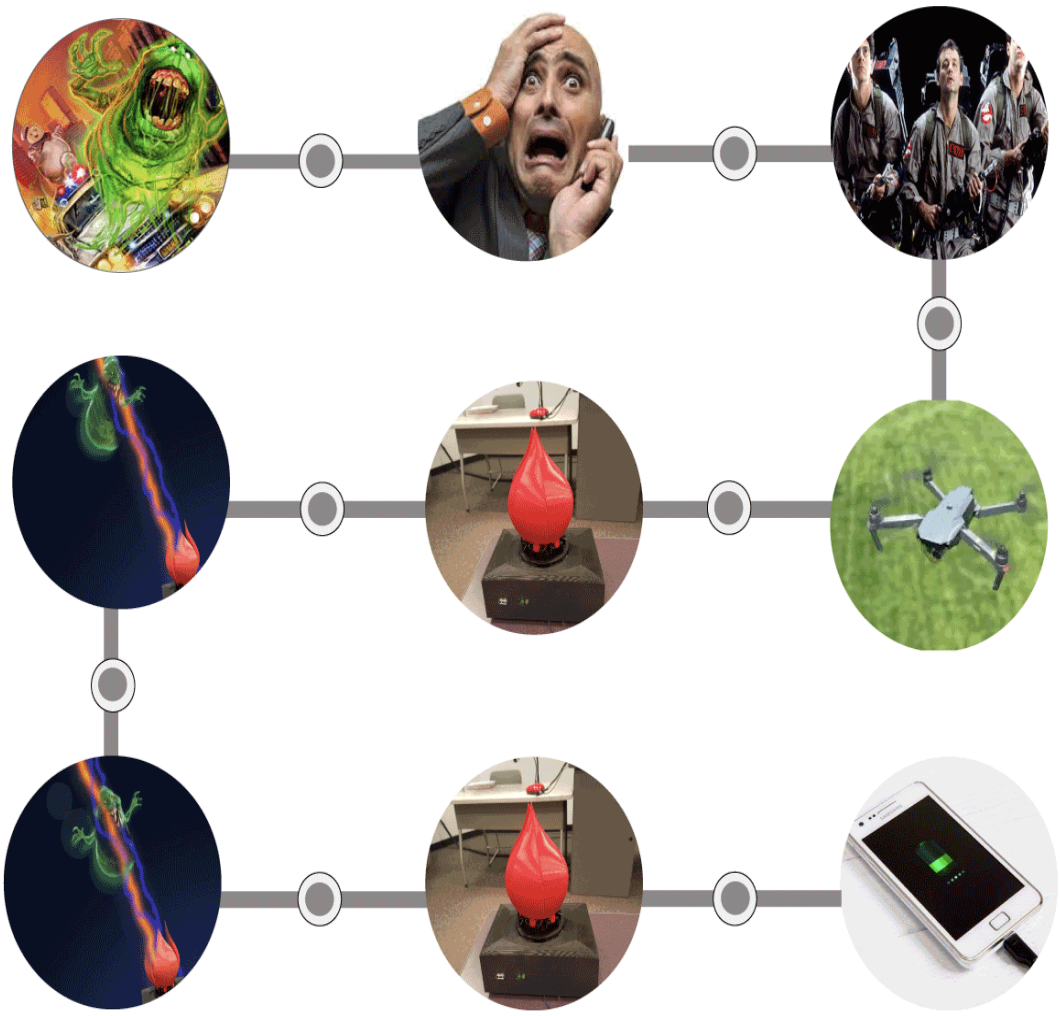

Fig 9. System Flow

5. Evaluation

An in-class evaluation of our high-fidelity prototype was conducted wherein the performance of the lotus ghost trap was assessed and through a follow-up questions/feedback, a quantitative evaluation of the prototype was assessed.

Number of in-class evaluations conducted - 4

The users were asked to operate the trap by pressing on the switch and based on the demonstrations, we asked them a couple of follow-up questions with a rating scale to provide feedback for our designs.

Tasks	***No. of errors***
Power on the button to call the drone	0
Identify the status of the trap using LEDs	1
Understand the working of the system	0

Our prototype in particular did not have a lot of tasks for the users to perform. The major task was to power on the button and when we asked the users for feedback, they said that the button was placed in an accessible place and was easy to reach on-the-go. Some of the users seemed to be confused with what the colors of the LED signified and we had to explain it to them. Since we explained it to them, we feel that it is a drawback that we need to address in our final design so that it becomes easily understandable in our final design. Overall, through this in-class evaluation, we also wanted to know if the users were able to understand the situation/scenario with which this trap will work to which we received positive responses.

The quantitative questions that we asked the users post our demonstration were -

On a scale of 1 to 5, how convenient it is to carry the trap ? 5 being most likely and 1 being most unlikely.

On a scale of 1 to 5, how useful is the trap ? 5 being most likely and 1 being most unlikely.

On a scale of 1 to 5, how easy is the trap to carry(is it minimalistic when you are on the go)? 5 being Excellently designed and 1 being Poorly designed.

On a scale of 1 to 5, is it easy to understand all the feedback and the status of the trap at all time? 5 being Agree and 1 being Disagree.

And some other open-ended questions for pure feedback such as -

One feature that you liked the most about the trap?

Anything you would want us to improve in our design?

5.1 Interpretation

Based on the evaluations that we conducted with the users, it appears that the trap is easy to carry and kind of minimalistic because of its simplistic design. But since the test was conducted on a small sample of users, the results cannot be generalized. The users loved the prototype for its efficiency and aestheticity. The users also appreciated the design for giving them proper feedback and they were able to visibly understand the status of the system. On the other hand, the users told us that the colors indicating the status of the LED are contradicting and that since the trap is fragile, there needs to be a mechanism in which the trap needs to be handled such that it does not open up and also remains intact.

The general feedback that we received on the design of the trap was that the heuristics were almost all satisfied and that the design with very minimal changes could help solve the problem that we are trying to address through this project.

For the likert scale questions that we asked the users post the demonstrations, the averages are as below -

Q1 - 4.25 ; Q2 - 4.25 ; Q3 - 5.0 ; Q4 - 4.75

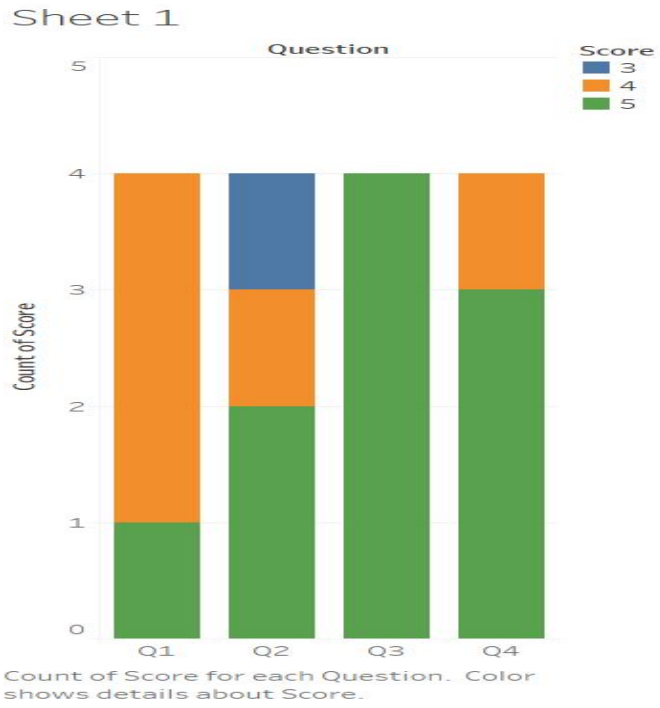

Fig 10. User feedback visualized

6. Discussion

Can you draw any generalizable conclusions for people designing for special populations like the Ghostbusters?

The main challenge while trying to analyse users is to understand the system from the perspective of the users. While designing for special populations, it is important to understand the users, the needs of the users, what is the gap that is available in the current system that does not serve their purpose and finally we need to understand the setting/situations in which they operate. These conclusions can be drawn by analysing the users and finding answers to the below questions -

- What are the current systems that they use?
- What are the outcomes that they expect while performing an action with the current system?
- What are the gaps in the current system that is not satisfying the users with the outcome that they are expecting?
- What are the situations in which they would use the current system?
- Since we are designing for special populations, do they have any special requirements or needs?

To find answers to all the above questions, the best way to start is to conduct a user research session and understand the user needs. Alternatively, one can also start with a literature review or researching up on blog posts available online to understand the users and to familiarize themselves with the current system. To understand and analyse the user needs and requirement in depth, a participatory design session involving the users and a focus group would be really useful to gauge their thoughts. Interviews (semi-structured or unstructured) could also prove to be very useful in exploring their wants. Taking inputs from the users will provide valuable insights about the system design. It is important to conduct user testing at each level of prototyping to get their feedback.

Applying the above strategies to our special population, the Ghostbusters, it is mandatory to understand the users in depth and the environments in which they will be operating. The ghostbusters were tech savvy people with an ability to easily adapt to new technology as and when it comes. Since they offer their help to the general public and work in different settings, they have many physical demands including constantly running to chase ghosts, going up and down the stairs, driving, maintaining balance during unstable building conditions. Apart from that, they also need to have great reflex and very active senses. All these demands great physical strength. As they are on the run most of the times as and when their service is

requested, it is essential to carry minimum number of things with them so that they are able to service their clients quickly and can reach their clients within time. It is also not possible for them to interact with complex systems at this hectic time. The system designed needs to be very minimalistic and easily accessible with a less or no load on the user's memory.

Does the paranormal present a particular challenge in interface design?

Designing for the special population, especially the paranormal brings up a lot of significant challenges during the design process. The biggest challenge is 'uncertainty' as the ghosts keep changing location from time to time, it is quite difficult to assess their exact location and pop up the proton beams on them to de-energize them. The problem that we are addressing through this design project is to eliminate the containment unit as it is very hazardous and to redesign the trap to let out proton beams and be extremely powerful in detecting the ghost. Since the location of the ghost keeps changing from time to time and the ghostbusters cannot tend to many ghosts at the same time, we have the drone locating the ghost and dropping the trap at that location for letting out the proton beams. Here we made assumptions that the ghosts leave cold spots and the trap opens based on the cold spot detections and shoots out proton beams.

Furthermore, paranormal activities mostly occur during night-time and it is essential that the prototype that we are designing operates in low-light. It should also be easy to open in low-light and the trap should be airtight otherwise the ghosts might leak out of the gaps. To spice things up and not trap the ghosts in a containment unit, we designed the concept of converting ghost energy(psycho kinetic energy) into renewable and reusable electrical energy with which we can charge our phones. Here, we assume that the ghost energy can be converted to reusable energy.

Does the environment significantly affect design decisions in a way that would carry over into other domains?

Environment plays a key role in any design process. In our ghostbusters trap redesign project, the environment was the main concern for which we eliminated the containment unit as it was very hazardous and the Environmental Protection Agency (EPA) had to intervene to shutdown the whole unit. The design decision that we took was wholly driven by the environmental factors. Also, since it is not possible for the ghostbusters to be in different places at once and the location of the ghost keeps changing, the design that we honed in on needed to consider and adhere to the environmental changes.

It is important in any design process, to assess all the details about the surrounding and the settings in which the users operate. Once we understand and analyze information about the surroundings, we will be able to design with the insights that we get from the surroundings and take those pointers into consideration as well. For example, since the ghostbusters are on-the-go almost always, we cannot make an app for them to use while on-the-go as their hands would be full with the guns, the trap and the heavy suit. In the case of doctors, even when they are on-the-go, a mobile app would be crucial to provide first aid to the patient by communicating with the caregiver.

To understand all these nuances, it is important for us to get to know the user's environment. The designers should understand the environment and the critical aspects associated with it. While beginning to design, the best way is to visualize the surroundings, the user needs and the shortcomings before hand to achieve the best possible outcome for the users.