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BRADY ENSTAD: Hi, everybody, we're Team Paul. I'm Brady Enstad, and I've primarily been the interviewer for the project.

LEXI DIEN: I'm Lexi Dien, and I've primarily the videographer and video editor.

YI ZHONG: And I'm Yi Zhong. I've been the lead scribe for this project. [INAUDIBLE]. So the first thing we started with is contextual inquiry using the HAAT model so just a quick review of what the HAAT model is. We are looking at the human activity assistive technology and then the context, and then trying to get all the aspect of the problem that we're trying to solve.

So the first thing we're going to talk about is Paul, our client. He has been an amputee for the past 30 years. He worked in IT before, but for the past two or three years he had a really severe hip problem. He couldn't really get around, and he had to stay home a lot. And he had a surgery in June, so he's able to walk again but with reduced arm strength. So that means he wouldn't be able to walk a long distance. He wouldn't be able to carry really heavy things.

And this is the AT he uses. It's custom-made forearm crutches. It's really expensive, and it's customized to Paul. And so some of the activities that he wanted us to do a project on are self-standing crutches, a mechanism to pull a suitcase, something to carry a slice of pizza, something to carry a cup of coffee, a self-standing umbrella, so he doesn't get wet in the rain. So all of these activities just kind of show that Paul really just wants to do things that people do and that he really wants to get out there again after this hip problem isn't bothering him.

And we narrowed it down to this problem; this is a quote by Paul, "it would be nice if I can bring my way of a cup of coffee. Wouldn't that be nice?" And we think, yeah, so this is the problem we that ended up pursuing. And then we dove into the context of this problem more.

So looking at it from a few perspectives, so culturally he doesn't want to use a wheelchair. Like I said, he had a hip problem before, so he had to be on an electric scooter, and he actually didn't like that all. He wants to use crutches. He wants to be able to stand. But because of the nature of his injury, he couldn't use prosthetics, so he had to use crutches.

And socially his wife helps him with many activities, including bringing him coffee. But his wife does have work, so he needs to do this by himself when he's at home. And physically he just wants to do this in his apartment. When he brews a cup of coffee in the morning. He wants to be able to carry it to the living room, something like simple like that.

And looking at it one statement, so this is our problem statement-- a design, a mechanism, that help him carry a cup of coffee around his home without spilling, and such that he doesn't have to grab onto it. And this is the way he carries it right now. It's kind of a grip and then while trying to use crutches at the same time, so you can imagine, it's really tough. And we kind of break it down to two main problems, which is how do we do it hands-free, so he doesn't have to hold it, and how do we do no-spill, so he doesn't spill coffee on his hands. And I'll let Lexi talk about the success metrics.

LEXI DIEN:

So right now, basically, Paul can carry a cup of coffee around with that claw grip, and he can only fill it about a third full if he doesn't want to spill it all over his hands or on the floor. We'd like to make that a larger amount of coffee, and we'd like to make sure that it isn't spilled. So for a livable goal we decided that maybe the coffee would be 2/3 full and he could not spill it. And then as an ambitious goal, we would say 3/4 full and also no spill.

Some other additional things we talked about were making it easy to remove from his crutch or from whatever it is; the technology is just easy to use and take away. And so we said 20 seconds for a livable and then 10 seconds preferably. We want it to be as quick possible. We also decided that we wanted to take Paul's perspective into this. I think that's very important. We wanted, especially, him to rate it, and we're hoping ambitiously to get an 8 out of 10. More livably, we think a 6 out of 10 will be something that we'd accept, but we really want to get as high as possible on his rating.

And the last thing we wanted to make sure is that we actually are able to use it with a mug. He uses his own mugs, and wants to be able to use his own mugs. So we want to make sure that it works for at least that mug, and preferably it works for a lot of his mugs or all of his mugs. So we're going to show you the video that we put together that gives you a little bit more background into Paul.

[VIDEO PLAYBACK]

-You know, it would be just nice if I could bring my wife cup of coffee. I mean, wouldn't that be nice? My name's Paul [? Nershimski. ?] I'm 62 years old. I've been disabled since I was 24.

-Paul uses forearm crutches because his imputation doesn't allow for a prosthetic. Despite the fact that his forearm crutches don't really let him carry things while he's walking, for Paul, the most important thing is to be able to move around and go places.

-And one the big dreams of my life has been to be able to carry around a coffee cup around the house like a normal human being with burning my fingers and ruining the rug.

-What really drew me to Paul was just the very simple nature of what he wanted, something that you and I take for granted, just the ability to transport food and even just a cup of coffee from his crutches to his living room without spilling it all over his floor.

-Cup full of water, not far from the brim, I would have to carry it like that, with my hand wrapped around the crutch handle. And maybe you can realized that would be a horror show.

-He wants to carry a cup of coffee around without burning himself, and that's very, very different from other people, other clients, had in mind. But this project's very mechanical. It's very simple, yet a really challenging problem.

-That may seem like not much to most people, but it's huge to me.

-There are many, many ideas floating around, but one of them is a gyroscope, something that would with the gyroscopic motion that can keep the coffee level while he's with his crutches. And this is one of the designs that we saw online that kind of resembles what we want to have. It's basically a cup holder that allows motion, that allows it to stay level when there is motion.

-There's a kind of silicon cover that goes over the coffee mug, and if it gets a good seal, then it works really, really well.

-Silicone cover does wonders-- nothing.

[LAUGHTER]

-So you have water in there?

-Yeah, it's pretty full.

-Wow, that's great.

-That really works. I mean, that's full. I try no to over think things, get like a real simple thing that I couldn't do. And you're making it so I'm going to be able to do it.

[END PLAYBACK]

LEXI DIEN:

So, as you saw in the video, we've been trying out a lot of different prototypes with Paul, mainly things that we found online, some things like this on-stage cup holder, which is basically a cup holder that can statically be just clicked on to his crutch, and it doesn't help tipping at all, so if it was an open cup, it would just pour out. But it's something that helps the hands-free aspect. And something like the water bottle holder would also do this maybe, except for it might not fit a mug very well.

So right now we're looking into some snap-on clamps, like this one. It would just be easy to snap on and off of his crutch so that he could take it off and on the crutch very easily and very quickly. So I'm going to pass these around for people to look at it. Some ideas for the no-spill solution-- as you saw, we were thinking gyroscope maybe. It turns out that that's a little bit more complicated than we thought it would be. It's a little touchy. So we're trying to look a little bit in a different way.

The second thing we did was the CoverFlex, which we showed in the video. It takes a little bit of time to put on and off though, so we were looking into some other ways, which one of them is this suction cover. So this is a mug, very easy. I'm going to pour some water into it and then put one of these suction covers on top of it, and no water will spill out. So we're hoping that this will be able to work for his mugs as well, and work on that a little bit.

Another thing that we're looking into, which is coming in today, is this Spill-Not, which is a device that's specifically made to counteract movement. When you place a mug on it, basically, that would make it so that it wouldn't spill hopefully. So we're looking into that a little bit more.

BRADY ENSTAD:

So at our client meeting for the first prototype, like I said, we showed Paul the on-stage microphone clip, and we showed him the CoverFlex silicon cover, and we left those with him this past week, and we're going to go back on Wednesday after class and get his feedback on those. He was actually more excited because we told him that the Spill-Not was coming. He was more excited about that than anything else.

But the CoverFlex, as you saw in the video, actually worked really, really well. The only difficulty with it is that once you have it on and take it off, like if there's been any spillage at all, it's a little difficult to get it back on again, which is why we decided to go with these suction covers. The only problem with those is they might not fit his mugs. So there's a possibility that we'll have to do a little bit more shopping around to find larger covers that will probably fit his mugs. That's honestly the biggest problem is his mugs are huge. So coffee addict, or something, but yeah, like I said he's super, duper excited about the Spill-Not.

And honestly one of our biggest visions for what will end up happening is that we'll be able to incorporate the Spill-Not with a quick on-and-off clamp, like the one that's going around. Like I said, the clamp, it works really well on-stage, but it doesn't really prevent spilling, and it's pretty slow because it's a screw-on/screw-off type mechanism, as opposed to just a quick clamp. He liked the CoverFlex, but if there's something that's easier, like those suction covers, then he would prefer that.

So for future work, as I said, we're going to be testing more off-the-shell prototypes, different suction mug covers maybe. The bike cup holder, we haven't entirely abandoned that idea yet either. And then obviously, the Spill-Not is what we're most excited about. We're going to go get feedback from Paul. And if he has some feedback for us that we can't meet with any off-the-shelf prototypes, then we're just going to do some customization for his final prototype.

PROFESSOR: So first of all, you guys have scoped this really well, in the sense that this is a really well-defined problem that you've worked out with Paul. And it seems like you're finding a lot of pieces to the solution that are already out there, that maybe you can combine to make something that's really good for him. So I would encourage you, or have you thought about-- let me phrase this as a question. Have you thought about the sustainability of your solution? So these cover flex things, for example, how do they fail? And how will things break? And what is going to have to replace? And sort of what is the lifetime of what you're building for him?

BRADY ENSTAD: So the great thing about the CoverFlex is that it's actually oven and dishwasher safe. So presumably, it's got a relatively long life cycle, and we're thinking, honestly, on the order of, hopefully, years because it is oven and dishwasher safe, unless he somehow super-duper heats it beyond what it's rated for, which I don't really know how you'd do that because it's oven safe.

And as far as the clamp, the hands-free solution goes, frankly it's a purely mechanical

systems. So unless he finds some way to snap off the clamp, which it could happen, don't get me wrong, but the great thing about these components that we found is that they're actually relatively inexpensive. And so the idea we have is that after the class is over we would leave him with these part numbers. Because he has a computer at home-- he's tech savvy. He used to work in IT-- so if something were to break, he could just purchased himself another one, assuming that there's not a great deal of customization that goes into it. And we don't actually know the scope of customization that's going to have to go into it just yet because, as I said, what we're most excited about is the Spill-Not, and we're not really sure how that's going to be incorporated with the clamp just yet.

PROFESSOR 2: So I would just kind of encourage as you're thinking about the failure modes, not just the individual failure modes, but kind of the cross-coupled failure modes-- as I was looking at the seal, one of the ways that you release the seal is by kind of flipping that edge, so you want to be careful that that edge isn't actually going to be affected by whatever your mechanism is for holding it. So think about the kind of the coupling that you get between your solutions, and not just the independent issues that you have with them.

One of the questions that I had for you was regarding your performance metrics, how you selected those on/off times, and how that related to his function versus the mechanical structure itself? And kind of from looking at some of your video, I'm wondering-- I couldn't really tell if he had any additional tremors or other issues as well that might affect his function that might affect that timing. So if you could just talk on that generation of timing?

BRADY ENSTAD: Yeah, sure, so honestly, we just asked Paul. We said, Paul, how quickly do you want this thing be put on and be taken off? And he said, well, relatively quickly, and he wouldn't give us a solid number. So we were just like, OK, you know, 20 seconds is a little long. 10 seconds seems like a reasonable time. The great thing about Paul is the only disability that he has is the fact that his leg is amputated. So doesn't have any tremors or anything else, any other sort of disability.

So I mean, as we talked about actually in lecture earlier today, it's possible as he gets older, those hands might start shaking and that sort of thing. But that's actually why we're excited about the clamp is because there's less precision involved. It's just a pretty simple snapping motion. So as far as like generating those numbers, it was just basically a kind of a general feeling we got from Paul, and we went with, well, what do you think about these numbers?

And the great thing about Paul is also one of the worst things he's incredibly laid back, so he wasn't particularly zealous about giving us hard numbers. So he was pretty willing to go along with anything that we suggested.

PROFESSOR 2: What are ways that you think that you guys might be able to validate those numbers a little bit more as you keep going and looking at some of these different designs?

BRADY ENSTAD: Sure, so if you take a look at the clamp, between positioning it and snapping it, I think you're probably looking at realistically probably less than five seconds. It's not real picky about where you put it on the crutch. So obviously, we're just going to keep adjusting those numbers as what's realistic becomes more apparent.

Like I said, we don't really know the degree of customization we're going to have to go to yet, especially if we're going to incorporate the Spill-Not. So once we get that and we do a little bit more prototyping, I'd be able to give you more solid answer for that. But as of right now, we don't really know.

PROFESSOR 3: I am a coffee aficionado, and I just am OCD about the cup that I have. I have two or three mugs that I just love. I can press the Keurig twice, and it fills it up just right. So I get that. But I'm wondering, have you talked with this gentleman about his ability or willingness to negotiate? To me, one of the obvious solutions would be to have-- because he has good hand function, presumably-- is to fill up a thermos mug and have a simple clip that you can put on his foreleg crutches, walk to a table, and pour the coffee into his delightful cup.

BRADY ENSTAD: So that's actually one of the very first thoughts that we had, and we asked Paul about that. And his reply honestly surprised us a little bit. He's not honestly concerned about carrying the cup of coffee so much for himself, as it is that he wants to help his wife out. Because while he was stuck in the wheelchair, he was really, really reliant on her, and so he wants to be able to carry a cup of coffee for his wife. And his whole thing about that is that I want to be able to carry it in the mug and just give it to her, and I don't want have to pour it out at the table or anything like that.

PROFESSOR 4: One or two quick questions from the audience.

AUDIENCE: So his Paul willing to have something on his crutches, or is that [INAUDIBLE], like the [INAUDIBLE]?

BRADY ENSTAD: So that's why we were talking about quick on/off times, and the answer to that is, no, not

really. He's OK with using it for the short period of time that it takes to transport the cup of coffee. But once he gets to the couch, he wants to be able to take it off because the way that he stores his crutches when he's sitting down, is he puts them on the floor. And so if there's anything attached to them that might possibly get in the way was his concerned. So the quicker on/off time, the better.

PROFESSOR 4: [INAUDIBLE] last question, then we can have Team Margaret also begin to set up as well.

PROFESSOR 3: The other quick thing I wanted to ask is, have you consulted an occupational therapist at all, someone who deals with these kinds of approaches on a daily basis? There might be some other simple solution that-- or maybe not so simple solution, but an established solution that someone has already dealt with. Because obviously, amputation and this kind of injury is fairly common and ubiquitous.

BRADY ENSTAD: And the answer to that is, no, we haven't. But that sounds like a really great idea, so we'll look into that.

PROFESSOR 4: Thank you.

BRADY ENSTAD: Thanks.

TANYA TALKAR: So, hi, everyone. We're Team Margaret. I'm Tanya.

LAURA D'AQUILA: I'm Laura.

TANYA TALKAR: And Beth his third member, but she's unable to get make it to the presentation today. So this is the team. I think we might have shown you this picture last week, but this is Margaret, our client. Interesting story about this picture-- she was actually the one who suggested that we take a selfie. So she's a great person. So a little bit about her as a person. She is an artist, so she loves to paint, loves to make arts and crafts. Her room is filled with a bunch of crafts.

She's also an advocate, so she's on the Safety Council for The Boston Home, which means that she's talking a lot with residents to make sure that they are comfortable with their position at The Boston Home and everything that's going on. And Laura will talk a little bit about The Boston Home. She's also a friend. She FaceTimes a lot on her iPad with friends and family, And she's an immensely helpful mentor, not only to us, but also all of the other residents of the Boston Home.

So about her disability-- she was diagnosed with multiple sclerosis, and she decided on her own to live at The Boston Home. So she has been at The Boston Home for about eight years, gotten during admission process. She gets around on a motorized wheelchair. All of the residents have wheelchairs, and she's relatively independent. She has some fatigue in terms of trying to sign documents, or after using her iPad for a while, she will get fatigued, and her fingers will drag.

But she is still relatively independent. And she was a social worker before she came to The Boston Home, which means that all of her thoughts and actions are really altruistic. She's always thinking about other people.

LAURA D'AQUILA: So this over here is a picture of The Boston Home. It's located in Dorchester, Massachusetts. And Beth, Tanya, and I go visit it every Friday to meet with Margaret, other residents, and staff members of the home. To tell you a little bit more about the home, it was founded in 1881 as a long-term care center for adults with multiple sclerosis and other progressive neurodegenerative diseases.

The average resident in The Boston Home is 58 years old, and The Boston Home places great emphasis on independence of residents. So we'll see later on that there's a lot of assistive technology that does exist within The Boston Home. There's 96 residents in the home and approximately 200 staff members. And it's a really nice place to live. They have activities, meetings, other social events, and it's known nationally for providing exceptional care to residents.

And this over here is a picture of Don, one of our panelists. He's done a lot of great work in the home for making sure that residents do have access to assistive technology. For example, he mounts iPads on the motorized wheelchairs of residents. He also has a 3D printer that he's used to design pieces of assistive technology.

TANYA TALKAR: So specifically, the activity that we've been working with for the past month has been the nurse call system or the call light system. And so what this is, is that residents, if they're in their room, can press a button-- we'll show it in a bit-- to call a nurse and call an aide to come and help them in their room.

So there's a wired-in call light system. It's a button that it has been wired to the wall, and nurses are currently trained to place this button in the middle of bed. Many times though, it's

forgotten about. So it's either not placed in the middle of the better, or it's placed in an unreachable spot. So Margaret sometimes has to come up to a table and has to either pull on the wire or pull on sheets to try and get the button.

And there's also just no way of using the system if the resident is outside the home. So. For example, there was a resident who had gone outside, got stuck in a ditch, and his wheelchair tipped over, and he was unable to call The Boston Home to let them know that this has happened. So they had to have someone who was passing by tell them that that happened.

So this is the call light system. The button is pretty easy to press. It's just like a simple press. But, again, it's placed in this kind of inconvenient spot, where Margaret can't reach. She doesn't have much of a reach, so she can't reach up to press the button if need be.

And so in addition to that, there's some other issues. Only one nurse is allowed to answer the calls at any time. Her name's Angela. And so she sit at the front desk, and this takes a long time if there are multiple residents calling in or if she has gone from the desk and has to address another resident's issues. So an aide also has to come in to turn off the call system, otherwise it keeps on beeping, and that is quite annoying for both the resident and the nurse.

Many times, if there are two rooms within a suite, as it is with Margaret, so enter a door and there are two rooms there, sometimes the wrong room is answered, so you'll have the nurse call into the other room. And since this is a speaker system, if the resident is unable to speak really loudly, or, in Margaret's case, she once pulling out a chest of drawers and it fell on her. So she was unable to both reach the call light system. And if she had, she wouldn't have been able to speak loud enough for the nurse to hear her.

And actually, to add to that, so that's the reason why we're planning on using an iPad for this solution. So we're planning on creating application, because Margaret always has her iPod with her, such that she can just press a couple of buttons and be able to talk with the nurses directly.

LAURA D'AQUILA: So to talk more about assistive technology, both what Margaret herself uses and what other residents at The Boston Home use, Margaret, along with many other residents, uses a motorized wheelchair to get around. And Margaret is very tech savvy. She owns both an iPad and an iPhone, which she always has with her. And she owns a special stylus so that she's actually able to use her iPad and reach all ends of the screen. And they've come in handy in emergency situations. Tanya mentioned the time when the drawer fell on Margaret and she

was unable to reach the existing call light system button. But fortunately, because she had her iPhone, she was able to call for help that way.

And the Tanya had mentioned that Margaret is an artist, and she's able to use a mouthpiece to hold her paintbrush, and that's something that Don had designed for her. And along with other residents in the home, Margaret has the call light system button in her bedroom and also in the bathroom. So thanks to much of Don's work, The Boston Home is very open to assistive technology, and it's very prevalent within the home now.

For example, there exists a cyber cafe, where residents are able to use computers, and both the keyboards and mice within the cyber cafe are accessible to the needs of the residents with their limited arm mobility. And there are also speech therapists and occupational therapists on site, and these individuals use technology, such as iPads, in order to assess the progress of the residents. And Don has added many features to wheelchairs throughout his time there too, accommodating the different needs of the residents.

TANYA TALKAR: So to assess how this application is going to work for Margaret and for the residents, because her vision is that at the end of this, we'll be able to have all 35 residents who are using iPads also use the system. We have a couple of success metrics. They're mostly qualitative. So, one, we just want to make sure that the correct iPad is being called and answered and that the correct resident is getting aid.

We will also want to time the amount of time that it takes for a task to be completed. So suppose Margaret needs a refill of water, so the nurse will come in with the call light system, get the request, and then go back to get the water. versus if we have this on the iPad application, how much time that'll take. And then just success overall-- does this application actually integrate into the current system with the nurses? Will the nurses actually end up using the system? Will the residents actually end up using the system as well?

LAURA D'AQUILA: So a few weeks ago we started discussing with Margaret potential solutions to this problem. Tanya had mentioned that we're going to be using an iPad. We work with Margaret to get her input and her feedback to actually develop some early sketches of what her end of this app looked like. And then within the next week, we developed this into a low fidelity iOS app, which I'll walk through now.

So this is the home screen of the app that Margaret is going to have access to. It has two large buttons that are color-coded red and black, for urgent and non-urgent requests. And

should Margaret press Non-Urgent Request, she's taken to the next screen, which has six potentially customizable buttons for a common requests that Margaret may have for the nurse. For example, if she needs a cup of water or if she wants a nurse to come to a room, if she wants to be able to video conference with a nurse, these are all buttons that are easily accessible for her to press.

And similarly, if Margaret presses the Urgent button, she's taken directly into a video call with a nurse. And at the bottom, there is a Cancel Call button for her to cancel in the event that she inadvertently pressed the button.

TANYA TALKAR: So amazingly enough, right after we transferred this application to her iPad, she immediately went off to go talk to some of the other residents about the application, which is great. And so some of the feedback that she came up with was that she wanted to make sure that the buttons were large enough, in case residents end up having some fatigue and their fingers start dragging on the iPad. So she uses a stylus, but not all of the residents do. So we just make sure that we have larger buttons for this.

She also wanted to make sure that there was an option to type in messages. So suppose any of the requests that a resident has isn't on the screen with six buttons, that they will be able to type in their own customized request. She also wants to make sure that she's always talking with the nurse through a video call because sometimes her message or what she wants isn't conveyed through text. And something that all of the residents said they wanted was that the application be voice-activated because not all of them are able to press the buttons at every time, and that they'll be able to go forward with this if they can't speak super well either.

LAURA D'AQUILA: So in addition to Margaret, because of the nature of the system that we're building, we actually have an additional client, and that's the nurse on the other end of the system that Margaret's trying to reach. So we had mentioned all of these nice features that we want the app to have, for example, video chat. And none of this stuff is feasible with the existing call light system that exists already within the home. So because of that, we're hoping to bypass the existing system altogether and have the nurse on the other end have an iPad or a computer screen as well with an instance of this app running so that she can receive the requests from Margaret on this app.

So because of this, we've had to speak with and work with Angela, who, as Tanya mentioned, is the nurse on the first floor, which is Margaret's floor, so that we can make sure that we can

accommodate her needs. In addition to Margaret's needs in terms of what this application should have. And we've also worked with Don to make sure that this app is feasible to be adopted within the nurse's station. And within the next few weeks, we're also going to work on speaking with other management level people within The Boston Home to make sure that we're able to get their go-to as well.

And one potential thing that we're still discussing is how to acquire a potential iPad that the nurse would need at her station. So we're looking into whether this is something The Boston Home would purchase, or whether it's something that we may need to get with our own team budget.

So in terms of the timeline, we spent the first month speaking with Margaret, getting to know her, her needs, and what she's looking for in a potential solution. And then in October, we were able to assess in greater detail the feasibility of an iPad-based solution on both ends. We worked with Margaret and Angela. We developed a low fidelity prototypes for Margaret and tested this out and received feedback.

And then in November, our plans include developing a low fidelity prototypes for Angela, for the nurses' side of the nurse call system. We hope to receive feedback from that and iterate through those prototypes as well. We also want to work on the back end of actually sending requests from Margaret's iPad to the nurses' iPads. And we want to get video conferencing set up the week after that. And then finally, hopefully by the end of November or beginning of December, we'll have an app that's able to be used within the home by not only Margaret, but potentially other residents in the home as well, and we can continue to test it out and get feedback from them.

TANYA TALKAR: So a little bit about how the logistics for this project go-- our meetings are pretty conversational. They're less like an interview, and more just us talking with Margaret, Angela, Don. So Laura is mostly in charge of the videos and pictures, and then Beth and I are the ones who are taking notes, asking the questions. And we meet before the meetings to go over speaking notes and go over an agenda of what exactly we want to be accomplished during the meeting.

As for division of work for the application itself, all of us are new to iOS development. So we're learning all of this together. We're planning on mostly working on the application as a team, all three of us together. And then for other things, Beth and Laura mainly worked on the video,

and I was mostly in charge of the report and the presentation for the mid-semester panels.

LAURA D'AQUILA: So to conclude, we're very excited to be working on this project with Margaret this semester. It's been a lot of fun so far, and it's exciting to us that this is something that could potentially not only benefit Margaret, but could also benefit many other residents of The Boston Home, should this be more universally adopted.

PROFESSOR 2: So one of the things that you guys mentioned at the beginning, as you were talking about the call system, was some of the regulations that are in place at the home. Can you talk about how your system actually can map to some of those regulations, and if they have to change in any way to use your system?

TANYA TALKAR: So that was actually one of the things that we are considering when we were thinking about whether we wanted to interface with the current call light system, or whether we would create this separate iPad application. And that's also one of things we need to talk with for administration. We believe that due to this being a separate application, we shouldn't need to have the nurses go in and turn off anything on the iPad, which is what they need to currently do with the call light system. And that's something that the company themselves had come up with as a regulation, that it would have to be turned off by a nurse aide. But for this, because it's the resident who's in charge of it, and they'll be video calling with the nurse, we believe that it shouldn't be a problem.

PROFESSOR 2: So I guess my question is, how does that regulation actually map? So not the fact that the system requires it, but what is the kind of the purpose of having that regulation requirement, and is it something that you guys should be matching or not matching? It's an open question. Is there a benefit to having the nurse specifically go there and turn off, and did they design that into the system not because it was needed for the system, but because it was important for the task?

TANYA TALKAR: So we've asked everyone about that. They haven't really been able to come up with an answer for that. Margaret herself kind of finds it intrusive that you have to come in and turn off the light manually, instead of her just being able to turn it off. So, yeah, we're not really completely sure why that is there. We just know that it's a regulation on the company's part.

PROFESSOR 3: Well, it's clearly a Department of Public Health regulation, and it evolved out of abuse and neglect issues, where you could respond to a resident or just repeatedly shut their call request off, without really addressing a need. But skirting DPH-- sometimes you sort of have to play

the game a little bit. So if it's an experimental or a redundant system, it may not have to match their regulations as long as the primary one meets those specific requirements of having someone go to attend to them. But I am curious how you honed in on that specific approach that you've taken of using the iPad and using that simple GUI, versus some of the ideas I had pitched initially.

TANYA TALKAR: So I think I was mostly through just talking to Margaret. And her approach to this was that if she was in a situation where she wasn't able to reach the call light system, her immediate thought would be to use her iPhone and call The Boston Home and try and reach the nurses through that. And so we felt that that would be a little easier to interface in that way, in terms of she always has her iPad or her iPhone with her.

And so suppose there were connectivity issues in terms of like we weren't unable to reach the - - suppose there was like a Bluetooth that was attached to the call light system, if that connectivity wasn't established and wasn't stable, then that would be an issue, as opposed to having Wi-Fi, which I think would be more reliable within the home and slightly outside of the home as well.

PROFESSOR 3: Good.

PROFESSOR 1: What I would ask is how much function does Margaret herself actually have? It's clear that you're trying to broaden this other members of The Boston Home, which is great, but what can Margaret herself do with an iPad app, and have you measured that, or have you observed her use of the prototype?

LAURA D'AQUILA: So Margaret has limited use of her arms, and it varies depending on how tired she is. So when she's particularly fatigued, it's even harder for her to reach the full screen coverage of the iPad. But because of the fact that she has a stylus that definitely helps, but that's also part of the reason why we had looked into adding the large buttons so that it's more feasible for Margaret and other residents to be able to use all of these functionalities of the app.

But, yeah, she can move her arms a little bit, but not very much. Tanya had mentioned that on the first day we met with her, we needed her to sign a contract for our team contract, and it was clearly a struggle for her to be able to move her arms to sign the document. When she paints, she uses a mouthpiece so that she can do it that way. So I'd say that her arm movement is pretty limited, but because of the stylus, she's able to at least get by with the

iPad.

PROFESSOR 2: We can probably take another one or two questions if anyone has comments.

AUDIENCE: I have a question. You talked about there was that situation when someone fell over and was stuck in a ditch. How could they access this application in the iPad? Are you considering [INAUDIBLE]?

LAURA D'AQUILA: Right, so maybe depending on the exact situation, they personally may not be able to use this app. But in the event that maybe there's another resident who's also outside, it may be a little bit easier for that second resident to call for help while they're still outside, as opposed to having to go into the building to alert the nurses of what had happened. But, yeah, in the event that it's just one person outside and depending on the situation, if they're not able to use the iPad, like if it fell or something, then I guess it wouldn't help them. But it's more so in the situation where there's multiple people.

AUDIENCE: I thought it was interesting that you had identified the nurses as your second client. It's very smart of you to do that. How many signals are they being bombarded by on an average day, and how is that going to affect how you would get their attention [INAUDIBLE]?

TANYA TALKAR: So Angela currently just has the nurse call system plus a computer set up at the desk. And then, of course, if there any nurses who are coming up to her to talk, that will be a distraction as well. So that was one of the primary things that we wanted to address with her when we talked to her. So that's why we're wondering, should it be on the computer, or should it be on a separate iPad? And she did tell us that with all the signals that she's getting, if it was on the computer, she would not be looking at it because you'll be most probably browsing other applications, if it's email or whatever.

And then with the call light system, that is also something that beeps whenever someone calls in, so she will address that. But if there is an iPad just mounted like right in the middle there, she'll be able to see that as a notification coming in. And she said that because of where she is sitting at the desk, then she'll be able to see that.

AUDIENCE: I just had a question. I noticed I didn't hear anything about what was the client [INAUDIBLE] nurse [INAUDIBLE] in terms of the [? hybrid ?] liability of this application. Have you guys considered putting that into your metric as well for success? Like what does she expect to work 90% of the time, 80% of the time? And also, what [INAUDIBLE]? You know, complicated

systems are complicated for a reason Maybe that's something-- like have you guys had a conversation with the client about this?

LAURA D'AQUILA: We haven't had a conversation about a specific number, but one of the benefits to the fact that we have this iPad system on top of the existing system is that in the event that Wi-Fi goes out or something like that in the home, and the iPad app that isn't working, then Margaret does have the ability to simply use the system that's in place, which I think is known to at least go through to the nurse pretty reliably, if not receive a response all the time.

PROFESSOR 2: All right, let's have Team [? Aaron ?] come up.

PHILIP: So hello, everyone. We're Team Kate. My name is Philip [INAUDIBLE]. And my teammates here are--

JENNY: Jenny.

RAQUEL: Hi, I'm Raquel.

[? PHILIP: So ?] today we're just going to talk about the progress that we've made over the course of the last few weeks in our project with Kate. Let me quickly introduce who our client is. Over the last few weeks, we've been talking about Kate. She's our client, and she works at the Cambridge Disabilities Commission. She has profound hearing loss, and wears a cochlear implant.

We also have this really short video, about two minutes long, in which talks about herself and a little bit more about the hearing impairment that she has.

[VIDEO PLAYBACK]

-Without my cochlear implants, I have no residual hearing at all, so that would be considered profound. With my cochlear implants, I have a mild to moderate hearing loss. But obviously, I do really well with my implants. You through in any background noise, and it's just you can forget about it. In this kind of setting I do really well with my cochlear implants.

So I was born with a very mild hearing loss. I just had like preferential seating in school. And it became profound or rapidly progressive when I was 13. It went from mild to moderate to severe and then to profound. I got my first cochlear implant my left side in 1999. I had my right side done in 2008, so nine years later.

It is not a quick fix. So when it was first turned on, everything, like my brother's would like stomp their feet, and it would sound like someone was ringing little bells. It was weird. And I couldn't understand any speech, but I had to force myself to turn my hearing aid off on the right side. And I was home from college for six or seven weeks. and I did all these listening exercises with my family.

We made it a game. Like my mom would take children's books. And at first, she would read them aloud, and I would follow along, trying to place what I was hearing with the words. And then I would graduate from that, and I wasn't allowed to follow along-- to read along. and I was trying to follow the story, just basically training my brain. So my brain was receiving the signal in a slightly new way. And so I basically had to retrain my brain how to take that signal and interpret it into usable sound.

I mean, I can't tell you how much it has changed my life though. Like I used to walk around college with a little whiteboard, and people would write notes to me. It has completely changed my life-- completely. So for me. It was so worth it.

[END PLAYBACK]

PHILIP:

So we've already seen from the video that Katie uses cochlear implants, and on this I would just like to mention that a lot of people who have hearing impediments still have functional nerve ending, the auditory nerves. The main problem is just that the part of the ear that is responsible for transmitting sound to an electric signals that are translated by the brain aren't functional. So it is that part of the ear that the cochlear implant tries to fix. So the cochlear implant basically provides a new channel through which sound signals can be transmitted to electrical signals for the brain to interpret.

RAQUEL:

So now we can get into a little bit of what our goals is a Team Kate. So our major goal here is to create cochlear implant attachments, so whether it's covers or clip-on add-ons to her cochlear implant to kind of hit on three particular sub-goals in this. So the first is to provide some water resistance to her implant. So currently, it isn't water resistant, and she doesn't have a cover that she uses for that.

So to give some context for that desire is that she, just like any of us, often finds ourselves in the rain. It seems like it's a great day to begin with, and by the end of day, it's pouring. So for Kate that means walking around with her hands like this, covering her implants, or taking off her implants entirely, and that's not ideal because she can no longer hear.

A second goal for our implant covers are to provide some sort of sound blocking. So Kate has issues in noisy environments. And what I mean by this is like in a lobby or a restaurant where there's just lots of background noise going on, she has problems distinguishing sounds that are coming from behind her from sounds that are coming from in front of her. So she's having a conversation with somebody. It's hard to actually comprehend what they're saying when there's lots of noise from behind. And currently, her implant just has a single microphone so there's no kind of sound directionality capability to it. And so an idea for this is just provide some sort of physical barrier to basically block sound from behind her.

The third thing here is attachedness. So she has a problem with her cochlear implants just falling off all the time for different reasons. But one goal for us is to try to just provide something that gives it a little bit more stability so it just stays on her head more. So the context of that one in particular is really just any place, any time. The context for all of these are kind of just very portable things that she can use in her everyday life.

So we've come up with a few success metrics. We haven't formally tested these yet. But for the water resistance goal here, we'll be doing something like a water bead test for the material to make sure that it's water resistant. I guess I should say that Kate has gotten a demo of her cochlear implant from the company that makes her implants, so we can do these water resistance tests not on her actual implant. But something like putting a material, like a paper towel or something that would show wetness, around the implant, putting on her cover, spraying it, and looking for signs of wetness and where that wetness is coming in.

Sound blocking, what we plan to do is kind of a human subject experiment with her. So what we'll do is play noise, a noisy environment behind her from different audio clips. and then have audio clips in front of her of speech or just a conversation, and try to kind of get her subjective feedback, and identify her threshold for the volume of that conversation in front of her, and when she recognize that with and without our different sound-blocking devices.

And then attachedness-- so currently, we've talked to Kate, and her cochlear implants can fall out up to 10 or 12 times a day, and this isn't even necessarily when she's being particularly active. So our goal is something less than three time a day, just something more reasonable for her to deal with.

JENNY:

So during our design process, we talked to Kate, and he's really, really excited about this

project because it has been a problem for her for a very long time, and she showed us a bunch of her existing solutions she has. She had a head band that you could hook the implants into, and that would keep them in place. But it's very sporty. It's a bright colored headband, and it wasn't something that she was pleased with. And then she also had some other kind of neoprene sleeves that she could put over her implants, but these technologies were all like pretty primitive, and they only served to solve one problem at once.

So through talking to her, we identified a bunch of feature that we wanted to address, the three features-- the water resistance, sound blocking, and attachedness-- and we began prototyping. So we each individually sketched designs so we could come up with many ideas when we came together. And as a team we chose the few to prototype out. And I'll show that on the next slide.

But we used [INAUDIBLE], which were two materials that we discovered during lecture. And then last week we presented the prototypes to Kate and did some informal testing. And she was pretty impressed them, and that leads me to the next slide of what we made so far. So at the beginning, we wanted to create some sort of all-on-one attachment that would address all three of the problems. So on the left, you can see it's like a unibody cover that covers the entire implant that also provides a hood over the microphone at the very top. And then there's also a little ear bud that would help with the attachments.

We decide not to go with that because Kate wanted something a little more modular, something that she could just have separate accessories for each problem. So when we prototyped keeping this in mind, we created separate covers. So the left of the top right photo are covers for the coil and the implant itself, the device with processor. And then we also created some sort of hood that you can put right over the microphone, which it's a little hard to tell, but the microphone right here.

So this hood, it provides a small barrier from the sound traveling from behind to hit the microphone. So we tried this out and then also compared it to these previously existing devices. They're called Ear Glasses, and these help also amplify sound that's coming toward you. And she was pretty pleased with them. And this was like very informal, so we plan to continue to prototype and iterate our design and then bring something to show her on Thursday.

For the rest of the semester, we're looking to continue measuring and testing out our success

metrics with the prototypes that we're planning to build. And then in November, we hope to finalize the design and the materials that we're going to use and then create our final deliverable. We're looking, like materials wise, we're keeping 3D printing in mind to actually create the attachments. But we haven't finalized it yet, so that's just something that we're looking at ahead. And that concludes our presentation. Thank you, and we'll take any questions.

PROFESSOR 1: First, that was a really nice video explaining her story with getting the cochlear implants and what kind of change they've made in her life. I'm curious about a couple of other aspects of your client that you alluded to a little bit, but I was wondering how important they are. First, how active or athletic is she, and is it important to her that these things be really, really secure? And second, how sensitive is she to her appearance?

RAQUEL: So she's not particularly active. What she did tell us is that she'll starting pool therapy soon for another condition that she has that we didn't talk about here, but that she'll be using the headband because it's really important that they don't fall off at all. And she'll be in shallow end and there will basically be no water touching them.

But so for these it's really just kind of daily life. She works in an office. She attends a lot of meetings. So nothing too active. She does ride her bike every once in awhile, and she has issues when she puts on her helmet. But again, she uses that headband that just really keeps it secure on her head for those purposes.

And about her caring about what she looks like, we actually did ask her straight up, how do you feel about looking a little silly? Is that OK? And she said that's fine. I think there's a fine line. We don't want something that's crazy sticking out. But I think she's willing to have a little bit of something extra on her head. She's even told us that she prefers it when people can see that she has a cochlear implant, instead of covering it up so that they automatically know that she has hearing loss so that they can communicate better with her from the beginning of talking with them.

PROFESSOR 2: So I'm wondering if you could talk more about that design shape. So you had the kind of Ear Glasses as something that was clearly doing something similar that provides that directionality. And in your design, you showed kind of two different methods of a different shape that was on that hood for how you're doing that.

I'm wondering-- I know you said you guys are still kind of the middle of testing and testing out

of it. How is that shape playing into your kind of design decisions? Are you are you specifically designing shapes and testing them, or is that more aesthetic?

JENNY: To be honest, we haven't tested that many shapes out yet. I think that when we do create a lot shapes, we're going to look at effectiveness before aesthetics. And we tried out different sizes so far, or we tried out three different sizes so far of the sound blocking piece, and definitely the largest one actually works the most effectively. So we're going to find a balance between portability and effectiveness.

PROFESSOR 3: Any questions from the audience here? If we can have the last team as well. Jeffrey, [INAUDIBLE] and get set up as well. Any other questions or comments?

AUDIENCE: How are the ear glasses supposed to stay on?

JENNY: As advertised, they were supposed to have some sort of adhesive strip that you can just pull off and then stick on. But they don't actually do that. It didn't actually come with that, so they just sit on your ear. But when we had her try them on, we just wanted her to try it on for the shape of the ear glasses. And she was really impressed by how big of a difference it made with her microphone.

RAQUEL: But these, in particular, won't stay on very well for us, and they definitely don't stay on with her cochlear implant.

PROFESSOR 3: I assume that magnets would be a problem with the implants. I don't know if you address that specifically. I'm just thinking of how well devices click in place. I'm just thinking quick one in the extruder head on the 3D printer, how would you just get sort of lined up, and it jumps into place. And I like that functionality, but I'm wondering-- I'm assuming-- that that would be problem with the implants.

PHILIP: It's actually one of the things that we considered. But just like you said, we weren't sure about how adding a magnet to the system would affect the way the outer part of the implanted part of it. So we haven't really tried that yet here. But I think we're going to explore that option a little bit more and see how it affects the communication. If it doesn't have that much of an impact, then we would use it.

PROFESSOR 3: Any final questions or anything like that?

AUDIENCE: One quick thing is you may [INAUDIBLE] think about the shape, the engineering of it. There's

some principles to apply to kind of engineer a shape that is most effective for sound filtering or sound blocking. That kind of thing. OK, Thank you.

Hi, so we're Team Jeffery.

JODIE CHEN: I'm Jodie.

DAVID KE: I'm David.

JODIE CHEN: And our client is Jeffrey. Here's a picture of him, and he's blind. So first, we're going to talk about contextual inquiry and how we worked with the HAAT model. So we came up with a few questions that we planned on asking him to kind of get an idea of what activities he enjoys doing and which activities we can help streamline or make more efficient and allow him to, I guess, enjoy it more.

So we kind of asked him questions like, what activities do you want to be able to do independently? And we asked him to show as an activity that he enjoyed in his free time and also like how he uses computers, because it turns out that he uses computers a lot. So I think one thing that we found about Jeffrey is that he's actually extremely independent, even though he's blind. He told us that like 75% of blind people are like unemployed, but he's been employed in multiple places before, and he also continues to do a lot of financial work.

So we have a video to kind of show, I guess, how he's I challenged our misconceptions.

[VIDEO PLAYBACK]

-Hi, so I'm David, and I'm part of Team Jeffrey with Jodie Chen and Yi Tong. And the client that we're working with for PPAT, his name is Jeffrey, and he's blind.

I guess initially going into this project, I didn't really know what I was expecting in terms of working with a person with blindness. I guess, part of it's like I didn't expect them to be super self-sufficient. And I thought they would have to be relying on a lot of technologies to go through their day. [? And so I was like ?] struggle with like a decent portion of the daily activities.

-I guess something that really surprised me about Jeffrey was how autonomous he is in like his travel and other stuff. So what you might not know about Jeffrey is that during our Monday and Wednesday classes sessions as well as class labs, he actually comes over and he listens and he also participates in our team discussions, gives all of like helpful advice as to like how do we really work on the project and how to build it.

-So I have plan A, plan B, plan C, and plan D. That's how you have to live OK, so here we're on my email.

-Jeffrey is-- you can barely tell Jeffrey's blind when he's at his place because he knows exactly where everything is. He's really passionate about technology.

-He is really passionate. He told me that he has the coolest gadgets.

-[INAUDIBLE]?

-What toys?

-You looked at this other wall while you were sitting there. I said, Jeff, what is it?

-I don't know.

-Remember, I said when I got here and he had this-- it's a talking thermometer.

-Oh, it's a talking thermometer, indoor/outdoor temperature. Neil plays with it more than I do because, frankly, I don't give a damn. It's too much information.

-The indoor temperature is 68.3 degrees Fahrenheit.

-I don't even know how accurate it is. It's a toy.

-And then he [? bought ?] this when he started cooking. It's a talking kitchen thermometer-- a kitchen scale.

-Oh, yeah, I tell you, he knows more the toys-- I forgot.

-Because I found them.

-(SINGING) Ah--

-Ah.

-Ah.

[END PLAYBACK]

JODIE CHEN:

So here's some information about Jeffrey. So Jeffrey, he's visually impaired, and he has been kind of for his whole life. He used to be able to see like different things if you blew them up really large on like a projector. But now, all he can see is like just like light and darkness. So he's used computers for practically his whole, so he's actually very, very good at using his JAWS screen reading software. And he actually teaches people how to use it in the Carroll Center for the Blind.

And he also knows braille, and he told us that actually a lot of blind people don't know how to read braille, so he's actually one of the few people that actually does know how to read braille. And he also does a lot of financial paperwork for his homeowner's association for his condo, and he does a lot of taxes for his friends. So he's constantly on his computer, checking his email, using Excel to work on that.

So we kind of wanted to narrow down like an activity that Jeffrey has to do that he wants, I guess, like more help in. So he's a pretty opinionated person, so he already had an idea of what problems he exactly wanted us to solve and also solutions as to how to solve them. So on the activities that he kind of narrowed down for us is finding a way to sign a paper with a wet ink signature. So he gets a lot of financial sheets and documents from banks and stuff that need him to sign the document and not have a digital signature. So in order to sign a document, he has to have his visual aide Neil come over and like help him find the exact line where he has to sign.

And if he doesn't have a visual aide, then there's no way for him to get that done. And she also uses Excel a lot, and he doesn't like the new format of Excel, so he wants us to kind of like change it to be more compatible with like the versions that he's used to. So we narrowed it down to being able to help him sign a document when he's like independent and alone, without a visual aide to help him.

So to kind of get a better idea of what we have to work with, we kind of asked him like, what assistive technologies that he currently use so to find out which assistive technologies that he was comfortable with. So he told us that he's really comfortable with JAWS, and that like when he does OCR on a document, he can determine where a signature line is because JAWS will

just say like, underscore, underscore, underscore. So all we had to do is kind of find a way to guide like his mouse pointer to like the position of the underline and then to find a way to convert that into like something that could be translated onto a piece of paper.

So for our success metrics we kind of wanted to be able to evaluate like how well he can sign a document by seeing if he can actually find the place where to sign independently on his own, which he isn't able to do right now. And we also wanted to measure like how long it takes for him to measure a document. And I guess that's pretty easy to improve on because currently it takes infinite time for him to sign a document. And we also wanted to measure kind of how accurate he is with finding the position and also signing because we don't want him to sign somewhere that's really far away from the line. So that's kind of like the scope.

YI TONG:

So I'm just going to talk about the project organization, the progress so far. So the first is the ideation. So we're very lucky, so Jeffrey's always in the lab, as you all can see. So he's been meeting with us every lab and also contributes a lot of good ideas. So we go to the lab with ideas and then consult Jeffrey and ask him for the feedback. And then we narrow down the solutions after every discussion. And then finally, we decided on the mechi and software combined solution.

So for the software part, so we all know that JAWS can detect a signature line and read out underscore and also like signatures and different kinds of words. So we just need to find a way to get coordinates from the mouse location, and then take in the mouse location two inches so that that can be the input for the mechi part.

So for mechanical part, we need a frame the holds standard sized paper so it won't slide away. And then we need sliding braille rulers, or rails, to move horizontally and vertically so that Jeffrey can adjust to the exacty x-, y-coordinates by sliding the two rails.

So here's the early sketches and also the prototype that we have. So on the right is just some white board drawings about different ideas that we had before. So the first one you can say something more or less like the magnifier that we see on [? Ability ?] [? Expo ?]. So basically the advantage of that is he doesn't have any restriction while he's signing things. But that is really hard to implement because the camera's on top of the paper.

And also we also get inspired by the idea of a project built by an MIT Media Lab. So it's a finger reader, so like whenever he scans a line, he hears "signature." Then he will start signing. But then that would require Jeffrey to scan through the whole page. And then so we

finalized on this sketch. So there are two siting rulers. Ideally, each ruler will have like brailles on it so that he can know how far he's gone on the page. So both rulers kind of slide left and right and also the other's up and down.

Yeah and then just the idea-- you don't you read it. But it's just how much Jeffrey's input is given to us, and also he's really passionate about this project.

DAVID KE:

So this is the general timeline for what we're doing. So in the next few weeks, it's going to be focused on mostly making more prototypes for these projects, and we're really ramping up our interactions with Jeffrey to get feedback and iterate on our designs. So like as you've seen in the previous slides, we already have a really lo-fi prototype.

So what we're going to do in the next two weeks is prepare multiple versions with minor detail differences to Jeffrey to see which ones he likes. Because a lot of it, the general idea is pretty solid, but a lot of it's like in the details of how unexpected things might come up as he uses it day to day. And in a few weeks, once we kind of have that hammered out, we'll try to work on like a more high fidelity prototype that this more closer to what we'll be presenting at the end in the beginning of November.

And on the software side, this is more like on our side because we need to kind of get familiar with hows JAWS is working, as well as like what kind of inputs to outputs we can give to JAWS as well as from JAWS. And then we're aiming to sort of complete that little bit after hardware, so we can kind of combine it together and have a few weeks to see how that would work as a complete package.

And this is just what we've done so far-- yay, teamwork. OK, and that's the last slide.

YI TONG:

Well, he obviously had a lot of ideas, and I'm wondering how you chose, or what process you used to choose this signature project? Was it sort of an embodiment of your skills and interests, or was it like clear front runner for him?

DAVID KE:

So I think two main categories we were considering in that was, one, is it something that aligned with our skills, because we're all studying computer science. He also had a bunch of projects that were pretty cool that wasn't that involved, like mostly mechanical engineering. So that was like a little out of the reach of our abilities.

At the same time, something else we have to consider was we needed a project that was the

right scope for the class. So like, for example, the Excel thing he mentioned, it's mostly computers, but it was very simple. So we wanted something that had more substance to it that could be applied to more people afterwards.

PROFESSOR 1: I have a question about your baseline success metrics because you did say that signing documents is something does do with Neil's help. Have you watched him to do that with Niel's help? Have you sort of collected examples of his signature that he's done with Neils help? Seems like that you're not just operating with something that he's completely unable to do, but something he just can't do independently yet.

JODIE CHEN: Well, he wants to be able to do it independently because Neil isn't always there. And we haven't really had a chance to watch Neil show him where the signature line is and how to sign it because, so far, we've only gone to his house once because he comes to Monday, Wednesday class sections, but also lab sections, so we've been meeting with him for around four hours every week during class time.

DAVID KE: Yeah, but I think that's a good idea, and it's something we should definitely do the next time we meet with him. I suspect we'll have to consider that as like two different categories of like metrics, but it's something that should be included

PROFESSOR 2: So I'm curious more about the mechanical aspect then. So you guys are really comfortable with the software side, and you presented the first prototype of the mechanical side, and you've showed kind of your sketch of how the camera might be there and where the rulers might be. But you talked about some of the limitations potentially for just being able to kind of look at where you put your head, where you put your hand. I want you to talk a little bit more about some of those limitations and things you're thinking about from the mechanical side, and what you think you might do to balance that.

YI TONG: I think I might have misrepresented because I feel like the camera thing is just like the earlier prototypes that we explored, but we're not going to do the camera side. We're just going to keep the software part, the mechi part separate. So the mechi part is independent. It only takes in the coordinates. And then Jeffrey will get feedback when he's sliding the rulers, so he knows how far he's gone, but he doesn't have to have a camera take down where his hand is currently on.

DAVID KE: Yeah, and one good thing about this is I think Jeffrey and us are pretty aligned in that we want to keep the amount of complicated components in the final project like minimized to reduce

possibility of failure. So a lot of the things we've actually talked about in the past few weeks are ways to simplify the parts so that it still has the relevant information, but it's like as simple as possible.

PROFESSOR 4: Any questions or comments?

AUDIENCE: You mentioned using a mouse [INAUDIBLE]. But wouldn't that require him to click all over the screen to find out where the signature line is, or are you just going to have he reads through it with JAWS and then stops when he finds lines.

JODIE CHEN: So it's more likely to be like the latter because he's done that. For JAWS, when JAWS is reading something on the screen, it has a [INAUDIBLE] somewhat similar [? to mouse clicks, ?] but they're not actually mouse [INAUDIBLE]. And then there's like a function in JAWS where it moves the mouse pointer to the location of where it's currently reading. So that's how we're planning on doing it.

PROFESSOR 4: Any questions, comments?

So quick clarification, so is there like a scanning-- maybe I missed it. Is there some scanning of the document first? Are you buying a scanner?

JODIE CHEN: Oh, he always scans in his documents.

AUDIENCE: I was hoping to [INAUDIBLE] Jeffrey briefly. Is it going to be an issue when the line is like a drawn line, as opposed to [INAUDIBLE] line? Or will that resolve with the scanner?

DAVID KE: That just depends on like the of quality of the line as well as like the character recognition software. So we'll probably do tests with that to see like how much tolerance the software has.

PROFESSOR 4: Michelle, last question.

AUDIENCE: Is there a general location where you know the lines are going to be. Just out of curiosity, like if I sign a paper, it's usually at the bottom right-hand corner. Do you guys have an understanding of what kind of documents he's currently signing, like what they look like?

YI TONG: According to Jeffrey, I think it varies a lot. And also sometimes like there's a huge line, but then the signature word is under the line, but sometimes it's just next to it. And then sometimes, the signature's right here on the left of page, but then you have to sign it to the right of the page. So it really depends on different kinds of paperwork. So we tried to collect all different kinds of

paperwork that he normally gets, and then we tried to characterize like what different kinds of signature box that he normally gets and then work on that.

JODIE CHEN: And also what Jeffrey does is he scans a document, and then he runs OCR on it, and then he translates it into a Word document, and then he prints out the Word document to sign. So what's going to happen is that he alters the document that he gets in mail pretty significantly when he runs OCR and changes it to a Word document.

DAVID KE: But overall he gets a lot of different signatures on that.

PROFESSOR 2: It would be really interesting to actually try out that and get those documents for all these different signature lines. And I think that's a really good point about whether it's an underscore line or a drawn line, and some signatures are actually boxes as opposed to lines and how that might affect it.

PROFESSOR 4: OK, thank you.

VYNNIE KONG: Everyone, we are Team Beverly Ann. This is our mid-semester review. My name's Vynnie.

SHRUTHI I'm Shruthi.

NARAYANAN:

ROBERT LUO : I'm Robert.

VYNNIE KONG: And we're just going to provide you a brief introduction to our client. So some of the non-technical things-- Beverly-Ann is a social worker for DCF, so that's the Division of Children with Families, so she basically works at a sort of law firm. And she's actually learning how to code using and Scratch Arduino, which we thought were pretty cool. She loves playing Wi tennis. She has a backyard garden, so she grows tomatoes and marigolds. And most importantly, she wants to maintain an active mind in order to keep busy and kind of like find something useful for the rest of her life.

And before we explain more about stuff related to the HAAT model, we think the video would be a very good descriptor of a lot of these things.

[VIDEO PLAYBACK]

-Hello, my name is Beverly Ann Rock, and I have been diagnosed with CMT, which stands for

Charcot-Marie-Tooth. I was diagnosed about 11 years ago. If there's any blessings to this disease or anything good about this disease, is it only affects the hands and the legs, which means I'll always have my ability to talk.

Three of my 10 fingers have taken on the deformity, which means they're kind of locked. And eventually, they will end up in gnarled positions. But fortunately, 7 is better than none. So I use my seven fingers very effectively. My right hand, it has become numb in many places. Thus it doesn't give me the opportunity to use very simple devices.

So if I were to be trying to drink something hot, I would make sure to try to grip it as best I can and support it. But over time, it's not going to hold. It's going to slip, I'm going to lose the grip. That's one of my concerns is dropping stuff and why I'm so guarded about dropping is if you drop a glass, a shard, I had a couple times, a little thing has just stuck into my foot, and I didn't realize it till I looked down and said, why am I bleeding?

I Constantly fall, and I always have devices or walkers or scooters or things that will enable me to maintain balance and continue to be mobile. I choose, at this point in my life, to work, even though I'm at retirement age, and that's because it keeps my mind busy. And hopefully every day they're working on a cure, or I stumble on a program like you that is going to assist me to make things a little easier.

So if I had a device that was telling me, if I got too into the conversation, that it's loosening, then I when know to go back and not use the assistance to go back and try to tighten the grip.

-We have to distract you some how.

-You are distracting me because why you're talking, I'm saying, OK, hold on.

[END PLAYBACK]

SHRUTHI

NARAYANAN:

So, as she said in the video, she has CMT. It's a neurodegenerative disease that affects the extremities, so the hands and the feet. It results in a loss of touch sensation and muscle control. So she has involuntary muscle spasms. For her, in particular, we're interested in her hands. So it means that she has sensory failures in part of your hands and muscle failure in others.

And this is like a general diagram of her left and right hand. On her left hand, you can see the green fingers are curled in like this. And that's because that's their natural position. So when

she tries to open them, they automatically curl back in. So this is like the involuntary muscle movement. But her other two fingers are very mobile. So even though she can't grip anything just with the left hand, she uses her left hand to support what she's gripping a lot.

On her right hand, the red regions, which are most of her fingers, are the places where her hands are numb, so she can't feel anything. And so she has a hard time gripping with those parts of her fingers. But the tips of her fingertips, which are marked in blue, are actually fully sensitive. So she tends to claw whenever she's picking things up. But over time, she still loses grip with her right hand.

VYNNIE KONG: Because of the combination of loss of pressure and also involuntary muscle movements, there are certain activities that Beverly Ann has trouble with on a day-to-day basis. And then I made a table with modifications that she's learned to do to adapt. So a lot of the things she has trouble with is having to consciously think about doing everything she does. So any time she has to pick up something to drink of water, any time she has to type something, she needs to think about every single letter she types, rather than just typing out of muscle memory. And that's difficult, especially when you're holding a conversation with someone or if you're just thinking about something else. You can't always think about what you're doing all the time.

This also helps with walking down stairwells, because she has to grip onto the stairwell and make sure she squeezes every couple of seconds, so if she's managed to stumble, she'll still have the grip and be able to stabilize herself. And the last thing is actually cooking, which he brought up in a meeting, where she realized when she was cooking potatoes and she was picking up potatoes to put them in the pot that she wasn't actually grabbing on to them. So she had to use this sort of like clawing motion to get them from the cutting board into the pot.

ROBERT LUO : So the basic problem we're dealing with here is that she has to constantly think about the things she's grabbing whenever she's grabbing some kind of object. And also, she is not really confident in using just her right hand for grabbing objects. Instead she normally uses her left hand to do the support. And we want to come up with the device which would help her by notifying her when she first-- helping her to have the confidence to grab objects with just her right hand, and then notifying her whenever her gripping starts to become loose.

So then we came up with the success metrics for our project. There are few things we can think about. So the first thing is we want to see how much of a percentage our device could give her the warning. So right now, of course, it's zero. But we think a reasonable goal will

50%. Meaning that our device will be able to alert her 50% of the time whenever her grip starts to become loose, and then with an ambitious goal of 90%.

And then the second success metric is the dropping rate with just her right hand. And so this part we still need to measure how many times, how many things she drops on average in a day, and then we want to decrease that by 50% as our reasonable goal, and 20% off the original as our ambitious goal. And then we want to boost her confidence in gripping objects with just her right hand. And we can measure how many times she grabs things in a weekly basis or a daily basis. And then we want to increase the percentage of her just using her the right hand to grab to 60%, then eventually 90%.

And so this is our design process for this device. So first, we define the goals. So we noticed that she has two different problems for her left hand and her right hand. And after talking with our mentor Jeff, we decided to focus on solving her problem with the right hand, so meaning the gripping part. Then we brainstormed of different ideas. We mainly focused on whether we should use a sensor, and if yes, where should we put the sensor as well as how we can attach the sensor to her hand? Then we come with various types of prototypes, many based on the location of the sensor as well as the style of attachment of the sensor. So the fundamental idea of our design is to have a way to quantify the pressures she exercises when she grabs things as well as trying to have a way to notify her when her grip becomes loose.

SHRUTHI

NARAYANAN:

So the first concept we had was to place the sensors near the palm of her right hand, so that would be in this area. We figured that we wanted as little material on her hand as possible, so it wouldn't weigh her down and so that it wouldn't look like a very obvious device. And then on the back of the hand, you can see there's a square. That would be where the sensors read out to. There would be some sort of output there that she could look or that would notify her when her grip is slipping.

So this was good because it was very small and condensed, and she'd still have use of her fingers. But it was bad because she tends to grip with her fingertips. So we wouldn't actually be able to sense a lot of the grip that she was using. And so we would basically get no reading most of the time

So then we came up with an exciting concept, which was to place the sensors on the tips of the fingers. If you can see, everything except for the index finger has a sensor. That's because she actually doesn't use your index finger very much when gripping. So the other four fingers

have sensors. They wrap around the back of the hand to go to the same output box. This is much better because she grips with their fingertips, so we can actually sense what's she's gripping. But it does take up more of her hand.

In the end, we went with a second concept, and this is because we asked her about how she felt about having a device on her hand. And she was like, I don't care what it looks like. It could be pretty big, and I would be OK with that as long as it helps me to grip. So we made some very basic prototypes of just the shape of what they would look like. So the sensors are the sort of strips of paper, and we just wanted to see how they would look so that we can sort of experiment with how they fit on her hand. So if you want to--

VYNNIE KONG: So a bit of a future timeline, we are planning by next week, so October 29th, to start and basically finished figuring out the circuitry for connecting these sensors to some sort of output voltage, and we want to tune the circuit so that whatever output voltage the sensors produce will be in a format that's interpretable to our needs.

SHRUTHI NARAYANAN: Then we want to write code to respond to the sensor so that we can give her a sort of output on when she's losing grip. So we want to study what the sensor voltage looks like as her grip loosens and try to figure out where we can start notifying her, when like this certain thing happens that, oh, your grip is loosening. So we plan to try multiple different algorithms for this, and this will hopefully be our second prototype, and we'll have it done by the first week of November.

ROBERT LUO : And then the third step is the actual glove we will use to attach the sensor with. So some things we want to think about in this stage is how we want to keep the sensors safe, which means we don't want the sensors to be exposed to the outside environment as well as her hand. So maybe something we're thinking about is knitting two layers of the gloves together and having the sensors to be in the middle. So that could protect the sensor from the outside environment as well as her hand.

And then we also want to think about questions like, what happens to the sensors when she curls her hand? So the way we think about it is that as long as we put the sensor on the back of her hand or on the wristband, it depends on which one we choose eventually. Both designs would be able to help stay stable, even when she curls her hand. And, of course, after we're having the prototypes, we want to keep improving on the device based on our test results with Beverly Ann.

VYNNIE KONG: A little bit about our division of work-- so during our client meetings, Shruthi he has been primarily doing the video. I've been primarily doing the interviews, and then Robert, the notes. And looking onwards, Shruthi and I will be planning on working mostly on the circuits, and then Robert on most of the gloves and figuring out what materials to use. And thank you, guys, for listening. If you have any questions, let us know.

PROFESSOR 4: Questions comments from [INAUDIBLE]?

PROFESSOR 1: I'm wondering if you thought about what you might do passively with the material of the glove to make it less likely that it would slip? You know what I mean? You have a very active solution right now that depends on sensors and electronics and batteries. Are there anymore passive things that you might do, either with material or with the design of the glove, or have you thought about that part of the space?

SHRUTHI NARAYANAN: So one of the big things we thought about was when we get the material for designing the glove, to have like sort of grip. So certain gloves do come with like rubber on the outside of them to have more grip, and we thought that something like this would also be able to help her generally keep her grip on slippery objects, especially with the glove on. So that's one example of a passive solution.

We did think of entirely passive solutions at the beginning, like having some sort of exoskeleton that would like hold her group in place that she could lock into place or something. But we figured that then she'd be having to manipulate the device too much herself. And so we went with the more active solution in general. But yes, smaller passive things, like the rubber grips and having some fingers open so that she has better grip, will hopefully help her with her grip anyways.

VYNNIE KONG: And we actually found out that a lot of her problems don't come from muscular strength. So it's not that she can't physically lift the plate. It's just that she can't feel how hard she's gripping it. So balancing it becomes a bit of an issue, for example.

PROFESSOR 5: Well, following on what you just said, did you think of any sort of way of giving maybe auditory feedback or some way to in terms of the gripping, like is there a user interface aspect to this?

ROBERT LUO : Right, so some things we think about is so after having a sensors, we want to be able to quantify her grip. And so some things we are thinking about is we can test how much of a grip she exercises on an object initially, and then set that as a threshold. And whenever the grip

comes down to 50% of the original grip, then that's the threshold we think of warning her. And then and then the ways of warning her include having a beeping sound, or it vibrates so she will be notified.

PROFESSOR 5: Did you think about cost? Did you say cost, like what it would cost to make one of these in quantity or something?

ROBERT LUO : Oh, right, so we already have the sensors ready. So we already got the sensors, so they were not too expensive. They were \$60, \$70. And then we know are on the stage of figuring out how the circuits would work, and we would approach it by making it on a breadboard first, then thinking of whether it's possible to make this circuits into a smaller circuit board and attaching it to the glove. And then the glove itself shouldn't really be that expensive.

PROFESSOR 5: Any quick questions from the audience?

AUDIENCE: [INAUDIBLE]?

VYNNIE KONG: We have not. What is that?

AUDIENCE: Oh, it's like thread that's in buckets, so it's like a wire, but it's thread.

[INTERPOSING VOICES]

SHRUTHI NARAYANAN: Yeah, I guess like once we have the sensors attached inside the glove to get it to the output, we could use that. Thank you for the idea.

STUDENT 1: Hi, we're team Barbara. So this is Barbara. She has been a teacher for 29 years, but she had to retire early because she has PLS. So PLS is kind of like ALS. It's a disease where your muscles get weaker. And right now she is living in the Leonard Florence Center, and she really values independence. And as of right now, she has fine motor skills in her hands, but is slowly losing her strength, especially in her left hand because she does a lot of crocheting during her free time, which keeps her right hand more flexible. And she's also constrained to a wheelchair, and her speech is sometimes unclear because the muscles in her face are also weakening.

So some of the activities that she has trouble with is opening and closing the door in her room. This is her door. And it's difficult for because the door is very heavy, and also it does not swing open. When she's trying to open it, it stays where you leave it and locks in place. Also,

because her wheelchair gets in the way because the door opens towards her, so she has to open it a little bit. scoot her chair back, and then open it some more, which makes it very difficult. Another problem that she has is turning off the lights before she goes to sleep because once she's in bed, it's very difficult for her to get up and turn off the lights.

Currently, she has an iPhone, and on her iPhone, these are some of the apps that she uses for assistive technology. The ones on the bottom here, some are for speaking because her speech is unclear. So, for example, there's one for her to say yes or no, and some of them where she can type in phrases, and it'll speak it for her. Or there's also apps for her to indicate the amount of pain she has right now.

She also recently got an iPad, but she hasn't been using it that much because it's heavy. But she has no assistive technology that she uses currently for opening the door or turning out the lights. So some of the context is that her room is right next to the dining area, so sometimes there's a lot of noise that bothers her. Also, she has concern for privacy because since the door is so hard to open, she leaves it open most of the time. And right now, the staff at the Leonard Florence Center has to open and close the door for every day and turn on and off the lights. And although she didn't ask for a solution for her voice problem, she did tell us that this is a major concern for her.

So based on my contextual inquiry, we decided on our project, which is to automate the door because she really wants to have the independence to be able to open and close the door by herself, and also have privacy in her room, and she doesn't currently have any assistive technology for that. And that is like the most difficult problem for her right now. So for success metrics we think the best possible solution would be for her to have an app on her phone that she would just be able to click or some sensors, so she doesn't have to actually opened the door. And a less successful solution would be for her to press a button and something that would just be able to reduce the amount of effort she needs is to have her pull something that would then open the door, instead of actually opening the door itself.

STUDENT 2:

So next we're going to explain a little bit about our ideation process for this door. So we're going to start by showing you a video of our design process and to give you a bit of sense.

[VIDEO PLAYBACK]

-This place, the Leonard Florence Center, is wonderful. They encourage you to be independent the best you can. I like the attitude. Hello, my name is Barbara [INAUDIBLE]. I

was a teacher for 29 years before I got sick. I had to retire early. I miss the kids. I miss the nonsense.

-What are your typical daily activities?

-Some days Bingo. I never played Bingo before I came here. It's to socialize more.

I struggle with the door since my room is so small. I'm in my own way with the chair, so to make it so it's easier without crashing into the door. The doors are very heavy for my left arm. Automatic doors in the room, would be very helpful.

-What would be your perfect world interaction with the door?

-I can open and close it without touching it. Some of the rooms already have the technology. Mine doesn't.

-So it's easy to open it. But then once it's not moving, it's hard to do either. Also, like the door will not swing open, so you can't just push it because it doesn't let it happen. It locks itself.

-Then we began our design process, which consisted of numerous measurements on everything related to Barbara's door. We then considered whether we wanted an app, button, or mechanical solution and started our ideation process. These ranged from an automatic collapsible door that opens with a pulley, to a mechanical lever that closes the door when you push on it, as well as a pulley system that opens and closes the door when you pull on the string. And lastly, we considered an automatic soundproof curtain system which would open with a touch of a button from pulleys. We decided to pursue the curtain idea, and are now beginning to prototype over and over and over again until we create the perfect automatic door.

STUDENT 2:

So that's just an overview of our design process. So I'm going to take you through the specifics of it now. So these are the three idea that we were pursuing for the door. And the first thing that we did was weigh the pros and cons of each possibility. So with the automatic collapsible door, we thought that this would serve as a good alternative because it's rigid, so it does still have the appearance of a door. But some issues we had with is that it was hard to find the parts to create a rigid collapsible door that was cheap and easy to put together.

Next, we considered automatic curtains, which we thought would be very easy to implement and test, and we get soundproof curtains that could implement that part of it. But one issue is

that it might not be door-like enough and fit in with like the norms of what doors simply look like, and the pulley system could get stuck as well. Lastly, we considered a mechanical lever and pulley system, so this would alter the door itself, so we wouldn't have any extra parts, and it should make the whole thing flow a little bit more smoothly. But it's kind of hard to implement, as we are not mechanical engineering students.

So we decided to go with the middle approach, as it is very easy to test and prototype. But when we went to the Leonard Florence Center with our idea to see if there were any issues, we found that there were a lot. One of the first ones is that they consider curtains a major fire hazard because she could get stuck, or the curtains could get in the way of her leaving or entering her room. They also told us that this idea must be fail proof. So if there were a fire, the door must be able to close, and nothing should inhibit its way.

So we tried to brainstorm another solution, and decided to go with our mechanical approach. But there we found that if we connected it with the fire alarm system, we could get our pulley to dislodge from the door if the fire alarm system goes off. And then this would hopefully not impede with the door's mechanism when there is a fire alarm. But still they raised the problems of a fire hazard, that must be fail proof, and they also did not really understand how we would connect our new door system to the main system itself. And if we were to go through the peak system that is currently at the Leonard Florence Center, it's super expensive. And so we found it this idea is not very feasible for us.

So this led us to work into her secondary problem, which is light automation. So the reason why this was her secondary preference it's she, with third condition of PLS, she actually can't get up from her bed to shut off the light before she goes to bed. So she has to call a nurse to do so. So this impedes on her independence. This happens every day.

So this would be a problem that if we could solve, it would help frequently, so she'd be able to have very good use of it. It's not like a one-case scenario. And this will also help her because in the future, when she is in a wheelchair, she may not be able to have the strength to reach up to the light to switch. Whereas with an application, she could, since PLS is progressive. So as a condition worsens this would be one of the this will be a possible solution that can like at least allow her to shut off the light when she wants to, and she's not in her bed for a longer period of time.

So different processes we thought of doing this, we thought of using X10. So while we were

searching, we found X10, so it's possible through Wi-Fi to send a signal to the X10 transceiver. That sends a message to the outlet through electricity, some sort of like Morse code for electricity kind of, to give an idea of what it's doing. And then that can be used to turn on or off the light. So the process would be a little straight forward, since the products are available. It would just be us connecting them, and then the actual application already exists. And the price tag was about \$100.

Another idea we thought of was a more hands on approach of getting in Arduino to send a radio frequency signal to the light. We could buy the light that have as a receiver for this radio frequency signal. So then we would basically send a Bluetooth signal from her phone to the Arduino [? BLE ?] shield, and then that would send the signal to the corresponding light. So this was an option that we could also have that basically we just have to have multiple receivers, radio frequency receivers that are on the bottom right hand corner. So then she could send different signals from her phone to control each and every light independently.

So it was an approach we thought of. The price tag on it was about \$70 because we would have to have the [? BLE ?] shield as well as the Arduino. And then the outlet, the receiver, was also a little bit of cash.

So then after that we like started trying to come up with how we were going to do this. And our next idea was WeMo. We saw this online. Basically, they have their own solution for it. Basically, you can connect to it through an application that they already have provided. The application is free, and the product actually costs \$41. So we thought of having this implemented in her system and then possibly expanding the SDK for the application so that she could have an easier time using it, and then have it basically tailored to her so that she only had to look at the application and touch larger buttons since the buttons are a little smaller than we would hope.

Possible next steps is what I just said, where we expand an application based off the SDK for WeMo and make that app available for her. Or if this ends up being a solution right of the shell, then we could possibly taken an avenue where after fixing this light problem with WeMo, go into the voice applications so try and see if we can tailor voice application for her.

So our timeline is by the end of October, we hope to have WeMo installed. The first half of November we hope to prototype the like UI for either the voice app, also, possibly, if necessary, the light app. Second half, we would like to have this app done in iOS. The reason

for prototyping [INAUDIBLE] it's faster, and we can get a lot of the UI feel really quickly. And then after that we would just keep testing and iterating until we have a product that fits Barbara's needs. Any questions?

PROFESSOR 1: Could you say a bit about how you're going to divide the work among the three of you?

STUDENT 3: OK, so in terms of the work for the door, we've been all going to the center to speak with as many people as possible. So for the time being, it's been a lot of contextual inquiry and a lot like designing all together. But in terms of the next steps for installing the WeMo, we were going to go to the center together and while two of the members were going to be working on installing this in the room, we were also going to continue to ask about the door, we are pushing towards like at least speaking to a lot of members in the center about the door, since that is an issue that we would hope would be solved in the future.

After that is installed, the dividing the actual application process, so since we, as a team, don't all have like skills in App Inventor and iOS, we were going to divide up so that we would end up having some of the base code that would definitely be necessary for iOS built right from the beginning while the UI is being prototyping in App Inventor. So in terms of like team specific, it would be two members working on the iOS application, while one member just continually prototypes the ideas that the team comes up with in App Inventory to like give a feel for it. We would always go as a team to show this to Barbara. And then once the App Inventor UI decision is made, we would all be working on the iOS apps since that's going to be the majority of the part. Any other questions?

PROFESSOR 5: So basically, the door is sort of too hard is basically-- it's just not workable?

STUDENT 2: There a lot of regulations with the door. We'd have to get it approved by the fire department, the public health department, and the people at the center, a lot of them don't even know how it functions and how it connects up to like the central system that closes all the doors when a fire alarm goes off. So it would require a lot more research, and we're not sure if it's feasible to finish this project in the next two or three months that we have.

JESSICA So we are Team Art. I'm Jessica.

HERRING:

RACHEL Rachel.

ELLISON:

STEPHANIE CHEN I'm Stephanie.

:

JESSICA

And what we have decided to build is a power lift. So first, we're going to introduce our client.

HERRING:

His name is Art. He is an adaptive rock climber, a hacker, a tinkerer. He likes to build stuff-- adapt stuff to his specifications and his desires, and he's a very active member of his community. He has a girlfriend, and she works in his hacker space at the Artisans Asylum in Somerville, which is pretty much a hacker space, where people build stuff.

However, he has T5 Asia B Paraplegia, which is an incomplete paraplegic. So he has some sensory function below his waist, but no motor function. In addition to this, he has a grade 2 shoulder separation that is not quite bad enough to need surgery, but we do want to consider this when making our design. We don't want to make our mechanisms too manual.

So Art wants to be able to work on the floor. He wants to be able to get under some of his bigger projects, like he'll lift up a wheelchair on his lift that he's designed, and he'll want to get under it. But it's really hard to do that when you're getting out of a wheelchair and you can't move your legs. So, in addition to that, if you were to fall out of his chair, he would like to be able to use something to get back up alone independently.

[VIDEO PLAYBACK]

-Well, I'm a [INAUDIBLE] minded person, a lot of independence. Before I got hurt in March of 2010, I was the person who took care of all of our household maintenance. I did a lot of motorcycle repair. [INAUDIBLE]. Pretty much [INAUDIBLE], I worked on it. Now, I still try to do as much of that as I can.

We're filming this at Artisan's Asylum, which is one of the world's largest hacker spaces, maker spaces and collaborative workshops that anyone [INAUDIBLE]. We have shops that cover an incredibly wide range of skills and technology.

What they call a T-5 Asia B, which basically means that from about here down I have no motor function. Because I can't get in and out of my chair easily, I'm more or less limited to doing things that I can sit in front of.

[END PLAYBACK]

JESSICA

He is quite a character, and he's very specific about he wants. But we figure that we can help him out with that. So our goal is to design something that's portable, something that's lightweight, something that is about the height of his chair that he can get in and out of and get up and down with. So the height of the wheelchair seat-- Art can only move about three or four inches vertically by himself. And so we need our device to be about the height of his wheelchair seat, which is 22 inches tall, but we'd also like it to be used anywhere he wants to use it. So we originally wanted him to be able to take it with him, and that's still one of our goals.

We also need it to weigh under 20 pounds. This is because he wants his girlfriend to be able to take it to him if he falls out of his chair and needs it or for some other reason. His girlfriend can only lift 20 pounds because she has a medical condition that restricts that. So our major success metric is time. A lot of these design constraints will make or break the project, but the time is a variable. So we would like it to be approximately one minute. Art wanted something a little more like 30 seconds to 45 seconds, but we think a minute would also be OK.

STEPHANIE CHEN

So after taking these design limitations into account, we decided to look into products that were commercially available. So at first, we began looking into commercially available medical technology. For example, that up there is something called an [? elk ?] emergency lift. It's probably the most ideal out of these products for our client because it weighs approximately five pounds and it can support 1,000 pounds. The only problem with it is that it costs \$3,000 at least, and there's no guaranteed stability if he's actually lifting in the chair. There's nothing preventing them from falling to the side.

And just for fun, we decided to look into other types of lifting cushions available in other industries. We actually found something called the Map Jack, which is something similar. It costs about \$800, and it can lift probably six tons-- fun fact. We then decided to look into the idea of a scissor lift, which is a relatively prevalent lifting mechanism. You can find it in construction sites and warehouses and so on. The problem with that idea is that there is a lot of friction losses associated with scissor lifts, and considering the fact that none of us are mechanical engineers, we decided it would be best if we started off with something a little simpler. And actually, if we consider the weight of a scissor lift into account, it would certainly weigh more than 20 pounds.

We then decided to look into a pool lift, which Art actually owns. The main issue with this idea is that unfortunately it's stationary, and we require a very powerful linear actuator, so we decided to scrap those ideas.

One idea that we actually came across is something similar to one of those stair lifts. It's essentially a sliding lift. It'll bring someone who's not capable of going to upstairs from the bottom to the top of their staircase. And Art was actually in preference of this idea. As you can see, based on the lower sketch, it appears to be relatively light design. And it's incredibly portable because it essentially looked like a tripod. And unfortunately, the major disadvantages of this is we, again, have to deal with a lot of friction losses, and we also have to include a bunch of fail safes such as hand brakes, just to ensure that he doesn't accidentally slide down when he's near the top of the ramp. And for this design we actually need a very specialized motor, something that's low speed and high in torque.

One idea that-- so this is actually our currently most worked done idea. It's a screw lift essentially. And that is a smaller scale prototype. Based on this drawing, you can see that we essentially take multiple 80-20 rods and arrange them in that sort of fashion, so you have one rod on this side and one rod on the other, where there's a seat in the middle. And in between those two rods, and what's holding up the chair, is a threaded rod. So essentially we'd be using either a drill motor or any sort of motor to twist that threaded rod to lift or to cause the chair to ascend or descend.

The major advantage to this is it can be designed to be rather foldable, and we don't have to build in any fail safes because we're dealing with a threaded rod. And actually, the motors required for this design are also relatively cheaper. But the major disadvantages to this idea, in particular, is that we have to work with multiple parts, and this could be a potentially heavy idea. So here is actually a video of the prototype.

**RACHEL
ELLISON:**

So this showing it does move. This me turning it by hand. And so if you're turning it at maybe 100, 150, it would be moving a lot faster. The [INAUDIBLE] we're looking at are eight turns per inch. So at 22 inches, we are looking at about 200 turns. So the next steps in our process really are to expand on these two ideas and decide which design to pursue.

Stephanie is handing around now 80-20 rod, which is the basis of our sliding mechanism. And really what we're trying to do is understand what parts we'll be able to get within our budget constraints and which one will provide a lighter weight design that fits more of our design

specifications. We'd like it to be full scale, our next prototype, and we're going to prioritize durability and sturdiness.

After that, we'd like to make a more polished prototype of our final idea. We'd like this one to fold up to be transportable and to be within our weight specifications. For our first prototype, we're not going to worry so much about that. We'd like to try to optimize the lifting time and the speed at which the motor turns to lift Art up and down. And finally, we'd like to think about the feasibility of mass production of this device and what is going into it and whether those things will be available for other users.

And so our projected costs with the slider design which is a little bit more expensive we're going to need a linear bearing to slide up and down the broad with hand brake built in so that it will be stable at the top of the ramp. And that's about \$65. For a high torque, low speed motor, those are pretty pricey and come at \$60 to \$80 new. We've been looking into scavenging this part to try to cut down costs. We'll also need other parts, such as hinges and legs, so that'll fold up.

For the screw lift design, we're looking at using a threaded rod, and this Acme thread design is a special kind of threading designed to bear weight and not snag so that we can turn it hopefully at higher speeds. We'll also need a low torque, higher speed motor. Those will be significantly cheaper, and actually we have several of those on hand right now. And the rest of the lift is going to be aluminum or wooden parts which can come from the hardware store.

So with that, I'd like to thank teammates Jessica, who's been in charge of videotaping our meetings and edited both the lovely videos you saw earlier, Stephanie, who's been heading up our prototyping and is going to be doing a lot of stuff with building in the next few weeks, and then I'm not going to thank myself, but I've been doing a lot of the interviewing and client communication. We'd also like to give a special thanks to Don Fredette at The Boston House, who's provided us with a lot of guidance, parts, moral support, Joseph Parse, in the Department of Material Science and Engineering, who helped us figure out the screw lift design and what parts we'd need to make it work, and finally our client himself has helped us a lot with the design feasibility and sourcing parts, and since he works at this hacker space, he's also volunteered to help us put it together, and, of course, the PPAT staff makes this class possible. Any questions?

PROFESSOR 4: We have about three minutes for questions.

- PROFESSOR 4:** Have you looked at Kiva Systems, a robot for warehouse automation? They were bought for \$600 million by Amazon a couple years ago. But they have a lift, a clever lift mechanism. Their founder talked to [? Mickey ?] last week. Maybe I can give you a pointer or two. They have a clever design. Maybe it's the same. But I do worry about the overall electromechanical robustness. Have you thought about how the whole-- the power, the connectors, the control everything puts together?
- RACHEL ELLISON:** We should have said something about this during the presentation, but Art has hacked into 24 volt battery system in his chair and has an Anderson volt connector that we can use to power our devices.
- PROFESSOR 4:** So you'll connect in to the wheelchair battery.
- PROFESSOR 6:** So that partly answered one of my question. I had two. One, what equipment does Art use at makers space, and two, has he adapted or hacked any of his existing? So yes, he has hacked his wheelchair.
- JESSICA HERRING:** He does that quite frequently actually. He replaces his joystick. He [INAUDIBLE] adjust the sensitivity for [INAUDIBLE].
- RACHEL ELLISON:** I think he uses the [INAUDIBLE], and he's built this foot peddle to help him use variable speed devices. He can't use his feet. I'm not sure realistically how much he's going to be able to help us with putting it together. But we thought it was really kind that he offered, and maybe there will be things that he's able to assist with.
- PROFESSOR 6:** [INAUDIBLE] it could be interesting to think about then going forward, even beyond the class, how do you design this so that he can continue tinkering with it after the semester is done, if he's already in a position and is interested in doing that. That's great.
- PROFESSOR 1:** So this is interesting in the sense that he's intentionally on the ground, right? You're not trying to recover from fall, which I think is where many of the other assistive devices are thinking about. I want to actually probe on this one minute time because if he's intentionally getting on the ground, he's maybe planning to get back up, and he might do it, in fact, frequently-- getting under, getting back in the chair to go somewhere else for a tool, then going back and getting under again.

Does the one minute that you're talking about, is that just measuring the time that it takes like

the motor to propel him up to wheelchair height, or are we talking about the time to set it all up, get on it, as well as move up?

STEPHANIE CHEN That's the time he wants to spend actually maneuvering himself on the floor to his chair. So we haven't actually taken into consideration setup time, though I guess that's another thing we can add in. But, again, that's going to depend on the design we choose, but some may be, I guess, modular in the sense that it may take some [INAUDIBLE] apart and actually have to assemble the entire apparatus. But for now, we're just focusing on the time length between him getting from the floor to the chair or vice versa.

RACHEL ELLISON: So another reason to favor this screw lift over the slider lift is that that's a lot more flexibility in how fast the thing goes up and down. With a slider lift, because so much torque is required to just move a pulley that way, we'd be looking at-- we have a minimum possible time of about 45 seconds. Whereas with the screw lift, pretty much the faster you turn the motor, the faster the thing moves. And then the only top consideration really is how fast we can move it safely. We certainly don't want to put him in risk of being propelled off the chair or dumped onto the floor.

PROFESSOR 1: I'd encourage you to include setup time as one of your metrics for at least [INAUDIBLE].

PROFESSOR 4: OK, any final questions or comments? All right, thank you, Team Art. And we'll jump right in. Thank you.

Hi, everyone. We're team Chris. So I'll introduce ourselves. This is Arthie. She's a senior, and she is our point of contact for the semester with our client, who we'll introduce later. Next is Carolyn right over there. She is also a senior, and she is the person in charge of keeping us on task during our meetings, make sure focused, and make sure that we're following our goals and aiming for goals every meeting.

PHOEBE: Next, we have Dirk, who's a junior, and he is our main scribe for the semester. And then there's me, Phoebe. I'm the main photographer and videographer for this semester. And, of course, our most important member of the team is Chris. He is a first year MBA student at Boston College. He loves to read, blog, and he loves baseball. So he has this rare condition called Miyoshi Myopathy, which is a progressive muscular dystrophy condition.

So he can only walk short distances and can only carry a small load at a time.

STUDENT 4: The activity that Chris would like us to help him with is just as daily movements throughout the world. Since he uses forearm crutches and a scooter, he needs place that don't have stairs

and elevators to get around. Currently, when he wants to go anywhere, he has to research that place online. He uses Google Maps, and he uses Yelp. Yelp has a little bit of information. But really what he uses is the Google Maps Street View feature because he can actually see where he can get up onto a sidewalk or the front door, if there's stairs up to the door and things like that.

If he can't get enough information from online resources, sometimes he can call the building, the restaurant, whatever he wants to do, and they can give him some more information that way. On campus, he primarily uses the disabilities office, and oftentimes he has to go in and talk to them because there's not very much information on their website. And can you go back? One thing that's really hard about some of these things, except for the phone call, of course, is that he doesn't know what's going on inside the building. He can't see that on a virtual application.

So we've decided he needs this in everywhere that he goes, but we've decided for the scope of the class to focus on his school and Boston College. Particularly, we're starting with the building that he uses every day, which is Fulton Hall. One thing about Boston College is that it's very hilly. So for Chris, that's really difficult. Some of the paths are sort of ramps up the hills, but they're very steep, which can be difficult for his chair and also scary. If he's going down, he might not be able to stop. And there's a lot of stairs on some of these paths. So actually he needs to go through buildings sometimes and use elevators within the buildings to get from a lower level of campus to a higher level or vice versa.

And then he's a very busy student. So if he needs a route like that that's not easy for him to see online, he might take a long time to get to his meetings or his classes, and that's a problem for him. And the other thing is students on campus don't really know these routes, and they're also very busy, so it's hard for them to help him out sometimes.

So our goal is to take the things that he uses right now-- Google, Yelp, knowing about stairs, and just going out trial and error, and finding these warnings by himself-- we're trying to take that uncertainty and bring all of these elements together into a central application that he can just go to this one place, see a map, and also go inside buildings and find out what things might be difficult. If an elevator isn't working. If an automatic door isn't working, if there happens to be something in the middle of the hallway that could be in his way, or a classroom that has stairs up to the seats, so he knows about these things in advance and doesn't have to deal with that uncertainty that he deals with every day.

DIRK: So Chris came into this project having a pretty good idea of what he wanted us to create, and that is an application that presents him all of this information in an easily accessible form. So our first goal was we needed to narrow down the scope, which we decided was Boston College. And even more than that, we decided to look at three different tiers of information. So the first one being at the building level. So this would entail essentially being able to see the entrances and exits that are accessible to buildings, being able to see information that is things like potholes or places like hills that are hard to access outside of the building.

The second tier is that of the floor level, actually being able to look into the buildings and seeing where the locations of elevators are, if there's stairs to get places, where the accessible bathrooms are located. And then the third tier is that of rooms, in particular, if there are difficult doors to get in, if it's like a lecture hall where the accessible seating is, which entrances he can use, and being able to present all of that in a tiered format.

So for our goals, we want to definitely be able to do the first and the second level. We think those are both feasible. We're hoping to get to the third tier as well. Beyond that, there are two different aspects the application, that being the front end and the back end. The front end is the visual display, what Chris will actually be using. And the back end is where this data that is being displayed actually comes from.

Now, the interesting aspect of this project is that because it is navigation-based, it's based on buildings and wherever Chris wants to go, ultimately his vision is to have this available for everywhere he wants to go. Obviously, that's not all feasible for the scope of this project. But we really want to have some sort of method built in that allows us to expand to future locations and be able to bring in different locations to this application. So we want to, alongside the front end on display, have some sort of method for bringing in new places and new data into the application.

As far as our actual prototypes go, we initially started by all four of us creating drawings explaining how sort of we saw this application coming together, and we presented all of these to Chris and discussed with him what he liked about each of them, and took the best aspects of each, and condensed them down into a singular paper prototype. So initially, he liked the map view that showed each of the buildings with alerts for where the entrances are and then being able to have things pop up, such as potholes, things outside actually getting to the

building the he might need to be aware of.

Then, when he actually clicked on the building, it would show up a actual floor plan, being able to look at different floors within the building. He liked the floor plan because it was very easy to navigate. And on top of that, having different notifications, different alerts, potentially color-coded that show different pieces of information, being where there are doors, stairs, elevators, bathrooms, all this information that he wanted to be able to see very easily marked.

One of the other big things that he wanted to make sure of is that we were presenting just facts about the building. He wants the information to be presented in a fairly raw form so he can then determine for himself this is somewhere I can go, or this is somewhere I can't go. As far as actually creating this, we decided on a web application because it was easier for us, as far as our skills coming in, and it was a lot more universal. He can access it from his phone, from this computer. And then we want to use JavaScript Node Express as far as our languages to be able to code that and Mongo for our database structure.

The success metrics that we want to use to measure this apply to the user experience side of this project, to make sure that Chris is getting the most benefit out of the application that we're creating. And so one of the metrics that we are using is the number of clicks it's going to take Chris to get a specific item of information that he needs. So, for instance, starting from the full campus map, we want him to only have to click three times to get a specific floor plan of a building that he wants to go into for class. And upon that, click only one more time to look at a specific room in that building or the specific elevator and to get the information that you need to know for that specific facility.

The second metric that we are going to use is how much time it takes for him to gather this information. So, as we mentioned earlier, his current methods are to call the restaurant he's going to, call the disabilities office, look at their website, and just look through Google Maps. And so we want to be able to time how long it takes him to get to find information about a specific classroom through those ways, and then make sure that it's about 60% less time for him to use our website to get that same information.

The third metric we're using is to allow for uncertainty-- not allow for uncertainty, but to reduce as much uncertainty as possible. And so that way within our website, he's not confused when using it, and so we want to count how many questions he has, and have a little help menu that he can use to clarify things. But also just to reduce uncertainty within all of his travel

procedures and to allow him to answer his questions before actually going out.

Now for our future plans of what we're doing for the rest of the semester, as Dirk mentioned, we're going to split this into the back end and the front end. So Dirk and Caroline are going to work on in the data aggregation and database set up, so getting all the information that we want to display and then creating a database structure that we can scope later on to add more details-- different types of buildings, different floors, different facilities. And Phoebe and I are going to be working on the front end to increase the user usability of the whole design. And since Chris wants actual facts that he can interpret for himself, we want to have a good balance of images and text and just make sure that he's able to use this in a clear way.

The timeline for this semester is until the end of October, we want to start our coding process and come up with a software prototype, and in the first week of November, work through our software prototype, and by the end of that, have something to present to Chris and have him actually test it and use it so that way we can revise and reiterate and keep going with it. And by the end of November, we want to have our final version that we can continue to reiterate throughout. And that's it. Any questions?

PROFESSOR 5: All right, we have four minutes for questions. Have you tried to work with Boston College to get the actual floor plans, like PDFs and things? Do you have all that?

STUDENT 6: Yes, so we're actually in contact with Boston College Disabilities Office right now, and they are working with the head architect to get the information. Right now we're just working through the legal procedures of which information he's actually allowed to give us and so what we're allowed to display.

PROFESSOR 5: MIT has a whole database. If you ever want MIT, I'll show you where it is.

AUDIENCE: How does he update it, like if a pothole is fixed.

DIRK: Yeah, so that's an area that we're still trying to figure out. We've had a couple a different ideas, one being trying to crowdsource that out somehow, having the ability in the app for users, if they notice something, to put that in as an alert. We've thought about contacting Boston College, like the maintenance or the facilities office, and if their staff notices things, having a way to put that in. So those are a couple ideas, and we're still trying to figure out exactly how the best way to go about that is.

AUDIENCE: Excuse me, we have a colleague in New York City that's done, in the past, maybe two or three

years ago, like a Yelp for people with disabilities for accessibility to buildings. I'm fairly sure the site no longer as fresh as it was during his NYU [? ITP ?] days, but we could put you in touch with them and see how they've updated or how they basically populated that information.

DIRK: Yeah, that would be great.

CIMMY: Hi, we're Team Felicity. I'm Cimmy. This Ari. This is Becca, and we're Team Felicity. This is our mid-semester review. Today we're going to show you our video, talk about the HAAT model for Felicity, our project vision, and our accomplishments so far. So we'll start off by showing you our video.

[VIDEO PLAYBACK]

-Let's like together develop a prototype of assistive technology that you will find useful.

-I have a disease called neurofibromatosis, which causes tumors to build up in the brain and spine. I had surgery last February in 2014 to remove the tumor on this side, which also took out my hearing nerve completely, so now absolutely profoundly deaf on each side. I also have a tumor on my optic nerve behind this eye.

My vision, I have days where my vision is perfectly fine, and I can see everything clearly. Then I have other days where things are just like really cloudy and I lose depth perception or have trouble seeing like walk signals, like seeing whether it's white or red or flashing. And I had a really close call a few weeks ago over in Fenway, where, because I know I'm impaired, so I'm looking for the light, and I still kind of like look because I just don't trust anyone. But I look for the light, and then a big truck comes right towards me. It was terrifying.

I pretty much rely on like reading people's lips, and then I'll take out pen and paper if it's like something that's really, really important or if I'm just particularly tired and don't have the energy.

I'm moving to a new apartment on October 1st, and they're installing flashing smoke detectors, CO detector, and a doorbell. I've never used a flashing doorbell before, so that will be exciting. I can feel the vibes. And I have like a computer that I watch captioned DVDs on sometimes. I don't have a TV or radio.

I set my phone to vibrate all the time for when I get emails and so forth. If I call you, then they'll

be a relay operator.

-I'm doing fine. Thanks for asking. Go ahead.

-Hi, I'm Ari. Hi, I'm Cimmy. Hey, I'm Becca, and we're Team Felicity. We've gotten to know Felicity a lot better through our meetings and have come up with a lot of neat ideas. We're excited to get going.

[END PLAYBACK]

CIMMY:

So, as you can see, Felicity has neurofibromatosis, which is a genetic disorder that can cause tumors to grow on nerve tissue. She had a few surgeries to take away some tumors, and due to those surgeries, she lost a lot of her vision. She can use her peripherals, and she's profoundly deaf on both sides.

The activities that Felicity likes to do are she really enjoys walking around Boston. She also actually has routine doctor's appointments, so she's usually between our home and the hospital. And in terms of context, Felicity lives alone at her apartment. She is unemployed and frequents doctors offices and the hospital. And she leaves the house minimally during evening. She doesn't like to be out at night. And she happens to be very open to letting people know that she is deaf and using assistive technology between that.

In terms of assistive technology that Felicity already uses, so to communicate with her, we have been using a notepad or a laptop with size 36 font so she can read it. And she also uses her iPhone, as you saw on the video. She receives emails from her doctor when she's out the doctor's office to notify her when they're ready for her. And she uses a Sprint relay app for phone calls and so on. And, as you saw on the video, a flashing smoke detector, and a CO alarm are installed in her home, and she also has a flashing doorbell, which the noise is loud enough that she actually feel the vibrations when they're occurring.

So now I'll switch over to Becca.

BECCA:

So I guess along the way of getting to know Felicity and her daily life, we like discussed a lot of activities that we could potentially help her design an AT solution for. We had to kind of whittle it down to one motivation that we could center a project around. And so the problem that we're going to focus on is that Felicity can't always detect when events occur because she's mostly deaf. And so these include like if people call her name, either at a cafe or at the doctor's office, or if a laundry machine's done, or when she's going on her walks, she can't hear cars honking

from incoming traffic. And so these are all situations where somehow RET could help her.

And so our goal for the project is to develop an AT that will notify Felicity when particular events happen. So this is variation came particularly from an email that Felicity sent to us with this hearing dogs video in it. I guess we don't have time to show the video, but the idea was just that she saw this hearing dog video, and at the end of her email she said, it would be really cool if I could have my own handheld hearing dog. And so that was a cool step towards, for us, to find a solution for her.

And so throughout so far, we've currently been going through an iterative design process to kind of whittle go down a solution and find something that works for her. We've been using low fidelity prototypes to get feedback from Felicity, even to narrow down for our project solution. And as we'll talk about a little later, our initial design process showed us that our project problem changed after discussions with her.

So this is just some example of some of the sketches we've done. In this example, we had two parts of a solution. One was a button that someone could pass for her attention, and the other would be some sort of wearable device that would vibrate, telling her once like this button has been pushed. Now Ari is going to share a little bit more about our initial problem statement and problem overview.

ARI: Right, so the first project we wanted to tackle was trying to let Felicity know when someone called out her name. And because she can't hear and she has limited vision, it's pretty difficult if she was in like a waiting room or the doctor's office or in a classroom to like figure out if someone's trying to contact her. So the idea we came up with was rather than having someone try to call out their name, we would have them have a button that they could press. And when they press the button, it would contact Felicity that they were trying to get her attention.

So this is the kind of overview of that design. We have a button that someone could press. It would send a message to her iPhone, and then the iPhone would display some sort of notification. And then we'd also have a wearable device that she could use, and they both display notifications. So kind of a two-step notification. Luckily, we really worked on doing iterative design and also user-centered design because we try talking with her about how well does she think this will work, and she really liked this idea. But she was concerned about other people using it.

And so one thing we tried talking with her is what would you like more? And particularly, she would want something that she could use possibly more often and also independently because this original project involves two clients-- Felicity and whoever we give the button to. And so the new focus of our project changed to try and make some sort of way to make sound emitting appliances within her home accessible for Felicity.

So basically within Felicity's apartment she has a few different household appliances that she doesn't know when they're done working. In particular, the laundry machine, when it's done, it just triggers a beep, and it doesn't have a timer. So she would like a way to know when it's finished. And basically the idea we have is we could have some sort of device that she could place next to the household appliance. And then when the appliance is finished doing whatever its task is, it will emit some noise, and this device would pick up on it and send a signal to Felicity to let her know that whatever the household appliance task has completed.

So again, we kind of kept last half of the project that we started scoping out and just talking about. And instead, now we have a microphone that would be placed next to the household appliance, and then the microphone would be sending sound to the iPhone. And within the iPhone we could have an application that would notify when the sound of the appliance finishing has happened.

So for the implementation we decide to use Bluetooth because this is in her apartment. It's less than 30 feet, and also Felicity leaves her phone plugged in while she's at her house. So we're not too worried about that part. And then right now we're all working on developing an iPhone application for detecting the sound and also the Bluetooth integration.

So these are kind of the hardware pieces we've been also testing out. The first one was a Bluetooth camera shutter button, and we also have a headset that we're just using as a microphone because we already have it, and we're just trying to do low-cost prototyping.

BECCA:

So to talk a little bit about the success metrics that we set up for our project, for the technical side, we broke down our project in two parts. There's going to be a noise detection to the iPhone part, and then the iPhone to the notification part. And so from there, we have like two activities-- the amount of noise that this microphone could withstand before, and also correctly detect the appliance. And those are kind of our levels of how good it would be, where level two would be ideal, and level zero is not actually doing its job, and then the number of noises it would detect. And then for the iPhone to notification part, the success metric would be like the

percent times the notification actually succeeds and is correctly pinging Felicity.

And then we have for overall performance, I guess the best way to measure our success is just how many appliances we can actually adapt this to. And so the laundry machine, dryer, toaster oven, and tea pot are just five things that we are kind of aiming towards being able to make this for. And also we're considering maintenance as well. Once we finish with this project, we want to make sure that all the parts of our project are replaceable so that Felicity can continue to use it once we're not there. From the UI perspective side, the best way quantitatively to measure this is just the average time it would take to set up a notification for a machine task that she has, and then also her own perspective about whether or not she thinks the UI is intuitive and easy to use.

CIMMY:

And in terms of our project development so far, we have purchased a Bluetooth camera shutter remote button, which was actually for our previous idea, in order for Felicity to be able to give a button to someone so that they could press it to signal her phone that she's getting a signal. And we started developing an iPhone application for the project that we've moved towards, and now we're investigating wearable devices that Felicity could wear for notification. And we're leaning more towards the side of some sort of wrist wearable or something that she could hold.

And in terms of our project's plans and timelines, this is just a general timeline that we have. We hope to get her iPhone app working at a low scale so that we can just have her iPhone connected with some microphone and see how well that works, if we're getting a vibration notification, gather appliances and a sound library by November 7th, and then test the app functionality. We want to focus a lot on having Felicity test out the app and see how well it works. And then probably by the 28th of November, we want to clean up the final project and work on the UI and fix bugs on the last week. Thank you.

PROFESSOR 4:

Questions and comments?

AUDIENCE:

So for the appliances you were talking about, like tea pot, laundry, and [INAUDIBLE], would it make more sense to use a timer for that? Because each of those appliances are pretty set timings for the [INAUDIBLE]. Would that be easier than detecting a sound [INAUDIBLE]?

BECCA:

So that's something that we asked Felicity about, and I think she-- oh sorry. That is something we asked, we brought up when we were talking about this is with Felicity. But, I think, one thing is like you don't always remember to set up the timer, or sometimes you just like run into

something else that you do. And so you told yourself, oh, I was going to do that. But she just forgets. And also when she's home, she doesn't keep her iPhone on her. So she usually has it plugged in, so if she can't hear the alarm, or even if it was vibrating, she just doesn't know if she's in another room or she's taking a nap to actually go and check on it.

So I think when we did introduce this idea to her, and we told her, well, there are like other alternatives that seem more feasible, she really liked the idea of having something that's preferably a wearable that just vibrates. Then she doesn't have to be thinking about it. But she'll know exactly when it's ringing that she should go back and see it.

AUDIENCE: Why do you need the phone?

BECCA: So I think first in terms of like implementation, it's a bit easier to have an iPhone app be the one that's sending the Bluetooth signal back to the wearable. And also in terms of modularity, I think, it would be a more complicated hardware solution if it was intelligently picking up just to send to the specific hardware device. I'm sorry, from like sound detector to the wearable, it's two more complicated hardware solutions. And so then it's the question of maintenance, like how is she going to replace these more complicated solutions?

But instead, we're using two kind of just all they have to do is either send a Bluetooth signal and then receive a Bluetooth signal, and that's like two much cheaper hardware pieces for us to get. And she could always replace those. And then the iPhone app is something that she'd already have.

AUDIENCE: How much is a Bluetooth switch?

BECCA: Yeah, so what we looked at so far, like out-of-the-box solutions to be like \$30 to \$40.

AUDIENCE: If you skip the phone, I guess, you would be able to use an RF link for \$5?

BECCA: OK, but would that be able to know-- like would the notification collector, I mean the sound detector, know to send it exactly to this Bluetooth wearable? Or is that a Bluetooth [INAUDIBLE] RF?

ARI: I guess one thing we'd also like to include is one of the reasons we kind of stuck with iPhone is we were interested in finding commercial products that we don't have to customize any of the hardware, especially with the button design. If it broke, she could easily purchase a new one. Like those buttons that we first shows, they're under \$10 to get similar designs. So what we're

really hoping to get is something that will work after we're done with the class. So you can purchase these designs and keep making designs that work with the iPhone, then why don't we capitalize on that?

PROFESSOR 4: So, Leonard, do you have a question?

PROFESSOR 5: Did you make an actual prototype for-- what was your prototype?

BECCA: It was mostly so far just like sketches. It was mostly sketches to show her like, OK, these are three pieces, two pieces, or like, these are kinds of pieces we're talking about, and then like whether or not you even like the idea.

PROFESSOR 5: Sort of like a storyboard?

BECCA: Yeah, and user [? flows. ?]

ARI: And we also brought the physical hardware of that button to kind of see how she liked it, would she feel like it's OK to use.

PROFESSOR 5: So you're going to run with that one? The you bought, is that what you're going to use, or are you going to use something else?

ARI: No, we're planning on switching to try to make something that only works with her independently because we're concerned about having the extra client that couldn't really control, make sure they were on board.

BECCA: So it's like microphone, iPhone, and then wearable or something to like [INAUDIBLE].

PROFESSOR 5: OK, I think we're at time. Thank you very much.

EANN: Hi, we're Team Don, and my name is Eann. This is Christina, and over here is Jan. First, we'd like to tell you a little bit more about our client. Our client's name is Don, and he is a male senior citizen who currently lives alone. He's a strong advocate for support groups, and he constantly tells us about how he goes to conferences and speaks to health professionals. And he suffered from polio during his childhood, and that is affected his left leg.

But in 2002, he also suffer from a stroke that affected the right hemisphere of his brain. So currently he has limited use of his left side and especially his left arm, and this has also

resulted in cognitive difficulties, especially in the late afternoon or early afternoon, whenever sometimes it's a little bit harder for him to process and to focus and to just kind of stay on track with whatever conversation he's currently engaged in.

From our very first meeting, we knew that Don loved food, and he loved to cook. So one of our very first questions was, what's your favorite flavor of ice cream? And this kind of transcended into this conversation of food, and we discovered that Don was actually a food catering manager prior to his disability. And when you first started at his job at KFC, he learned about his passion for cooking and expressing himself through food.

And so as a result, he still cooks, and he constantly talks about different recipes. And we got the opportunity to make omelettes with him one day. And so with his left hand, it typically is stable, and he uses his right hand to cook. And with his left hand held typically either brace apart or hold onto a cheese package, and rip open the top. But typically, it's only just his right arm that he uses, and it's essentially his only method of cooking-- or only manner of cooking.

And so this you can see is in his actual apartment. We got the opportunity to go visit Don in his apartment and kind of see where he lives and see where he actually takes the time to cook. And so we noticed that is apartment is actually-- his kitchen is actually fairly small. It is about the size of a small kitchen in Burton Conner, which is a dorm on campus. And you can see in the next slide that the stove is fairly close to the sink, and so it's a pretty small quarter for cooking. And he's looking for a way to improve the mobility in his kitchen.

The assistive technology that Don uses includes Velcro, which is on the left hand side. He constantly tells us that Velcro is his friend, and he uses Velcro for his shoes. And on the far right side, he also uses a leg brace that prevents him from hyperextending his knee. But the most important assistive technology that he uses is in the center, his iPhone. So you can see, he's clearly really excited about it, and he's constantly using it to schedule tasks, to send emails, and he depends on this iPhone to remind him of his daily tasks.

So in addition to those three items, he also uses a cane to help him walk. And so this is a quick video of him using his cane, and it's just simply to help him walk and to assist him in being mobile.

JAN: So some challenges we've already seemed to have faced in this design project is our team scheduling. So it's really hard for us three to get together with Don at the same time, same place, and get something going. And with Don's cognitive overload, he also has issues

focusing and telling us what he really wants for us to do on our project. So we initially started out with two projects that we were going to work for helping him with his cooking.

As you can see here, we started off thinking of ways that we can help him out in the kitchen. So something that he did mention to us was the fact that he needs some help carrying big pots. So since he has one arm, it's really hard to actually stabilize the pot and move it from point A to point B without having the contents spill and move around too much. And another thing that was mentioned to us by-- oh, he's not here today-- another one of the actual participants of this class, Jeffrey, was something used for stirring or stabilizing the pot whenever he's either stirring or doing something with the contents of the pot.

And we initially started off with two different projects that we were going to test out with Don and figure out what he really wanted out of us in this class. So the first one was the stability of the mixing pot or doing something with the pot or a bowl. And we decided that we wanted to focus on these three little things, so minimizing how much the bowl moves, how much it tips over, and making sure that whatever we use is fast and easy to use. And as for moving pots, we wanted to focus more on how he can take these pots from point A to point B, so large pots with a lot of things inside of them, and minimize how much effort he has to put into moving these things and stabilizing them, while making it very easy to use as well and minimizing how much liquid falls off or how many things could go wrong with this.

So we initially started off with some design prototypes for the stirring or for slipping is something that we called it. So we started for slipping, and we showed him some of these designs, and we got some very good feedback from him. He was very, very opposed to having something big and clunky in his desk or his workspace whenever he was cooking. And we used that to further our designs and make sure that we go with something smaller, something that doesn't get in the way and is very easy for him to use.

And after that, we showed him some of the things that he may want to use for moving a pot. So over here, we can see something that can adjust to a pot and use some sort of strap around his forearm or shoulder to move the pot. Because he mentioned that he has some what we thought were really big pots to move around for a pretty long distance. This was before we actually went over to his house and found out what we were working with.

And another thing that we thought was maybe-- he says he slides the pots a lot because it's a lot harder for him to carry them. Something that we thought of was maybe having a little

mobile station for him to use, where he can slide the pot onto it, slide it across the floor, and then move it onto the actual stove itself. And finally, this is just some brainstorming/prototyping. We thought of like those things that drummers use, where they attach it to their chest, and you can pot in there. But this is just for brainstorming. We just threw ideas out there.

And we showed these ideas to Don, and we decided that we were going to go much further into the actual movement of the pot, rather than the stirring, since he says that that's one of the big challenges that he has. And that's where we are currently at. We have identified the problem and know what we're going to do from here on out.

CHRISTINA:

So this past Friday we actually got to go to Don's apartment to actually see what his kitchen is like and what his cooking environment is like. And so before we were initially imagining that he was using pots that were like this big and that you would need to use like two hands to carry. But we actually found out that they're actually normal sized pots which you can carry with one hand, and also the thing about his kitchen space being very small made some of our initial designs not feasible. So here you can see a video of Don in action.

So, as you can see, Don has trouble moving filled pots from his sink to his stove top without having some of the contents spill out. And so we kind of made a sketch of his kitchen layout. And so the task requirement that we decided on was that we wanted to help him be able to lift and move the filled pot and also not spill any of the contents.

And so these are success metrics. Them metrics include lifting and moving the pot vertically as well as horizontally, and then the amount of spill there is , and also how much time it takes for him to move the pot from the sink to his stove top. And so we kind of evaluated the current state of how he accomplishes the task, and we used a scale from 1 to 10, one being we would really like to help him improve in this aspect, and 10 being this is OK, and this is great. So we have our current goals, or we have the current situation, and we have the target. And we also have our reached goals.

So our contributions up to date-- since we haven't really gotten into the prototyping part yet, we have all been designing and brainstorming together. And so Jan has been facilitating the meetings. Eann has been documenting and taking notes, and I have been taking videos and also photos. And for our future contributions, we are going to continue doing what we're doing right now. Also, once we get a better idea of what are design will be, maybe split up the tasks

for what different components of our product that we are going to be working on.

So I guess like our most crucial step is our next step, which is like in the immediate future. So we really need to be able to come up with a design for our first prototype and get it to Don and get his feedback on it. So one of the main things that we will be focusing on for this first prototype will be mechanisms and concepts for how he can move a pot from a certain height to a higher place. And also, we might be considering the material that we will be using the product because that relates to, I guess, like how much mass he can move. And we will also be doing a more quantitative evaluation of Don's skills, so maybe like how much mass he can lift, or how long can he hold up a pot for.

And so these are our project plans. So, as I mentioned before, our main thing right now is to get our first prototype out and get his feedback on it. And then from then on, we can add more details into our planning for how we are going to finish this product.

PROFESSOR 5: Any questions? Great, thank you.

PROFESSOR 6: Did he articulate any other scenarios of where he would move the pot, aside from stove to sink?

JAN: No, that's the only one we actually saw him doing physically. But I imagine that he would have to potentially move something that has like maybe spaghetti to cool it down somewhere else and maybe actually serving with the pot, so from his to the kitchen table. But that's the only one we actually saw him doing, and that's why we are going to get some further tests to see distance, weight, and other things that could potentially play into our design.

PROFESSOR 6: So I was wondering that about how that may impact your metrics or quantitative metrics of being able to move it three feet.

AUDIENCE: Maybe you want to try to try to get him to fill the pot and move it while there's hot liquid because that may make a big difference. And he was very aloof about splashing cold water, but he might not want to do that with boiling water.

JAN: No, we didn't want anybody to get hurt there.

AUDIENCE: Did you guys try the pot-moving thing yourselves to see how much-- you filled the pot all the way to the top. How feasible is it for like one of you to do that?

JAN: No, we did not. It's something that we should have done. You're right.

PROFESSOR 5: So imagine everything goes amazingly well. What will you actually make? What will you actually do? Will it be a redesigned pot? Is it sort of like thinking about the procedure of how to do these tasks? You can imagine building a robot that could do it. It would be like really hard. What are you actually going to do?

JAN: So what really thought was an attachment that you can adjust to almost any type of pot. So one that I showed over there was something that you can put around the top side of the pot, so a belt or some type of thing, where it hooks on to the top of the pot, and you have belt on top of it, where he can-- he says he would really like to be able to really use his forearm because his fingers also get really tired, to be able to put the belt over his arm and then carry it over, using that, rather than the handle, where he doesn't have as much stability.

PROFESSOR 1: I do want to echo what was said over here about heat. I think that the fact that you didn't mentioned that at all in your success metrics or in your constraints is actually a pretty serious problem, right? He's moving a pot to his sink-- I'm sorry to the stove in order to heat it up. And then if he's going to continue to be independent, he's going to have to do something with that hot, still heavy pot. So you need a consideration here which is that he doesn't burn himself.

And I think that spillage may be something that you should give a little less concern to because that can be solved by not filling it up as much because that would boil over anyway, if you filled it up as much as he actually did in that video or by putting lids on it. But I really would encourage you to worry much more and pay much more attention to the problem of heat.

JAN: That's something that we'll definitely take into account then.

AUDIENCE: Especially if you're going in the direction of putting something that's close to his body. And you can do tests with him not burning him, like put food coloring. Have him wear something he doesn't care about, and see if he an immediate reflex if he's spilling food coloring on his clothes. It'll give you a better sense of is he really that confident with this forearm, for instance.

PROFESSOR 5: So it's a really hard problem. In some ways, I'll just be honest, like when I first saw this compelling client, and it's like, this is a great person. It would be great to help him, and I know that he loves to cook. But dealing with pots full of water, possibly hot water, that just seems like a really hard problem. And I wonder if there's something else you can do for him that's not so physically, like something that doesn't have a safety dimension. You don't want to give him

something he's going to burn himself with badly on his own. You know what I mean?

JAN: Yeah, we could also take the alternative approach, the actual stirring or moving the things within the pot.

PROFESSOR 5: Or maybe he just lets it cool for a really long time. But how do you get the food out? I don't know. Maybe there's a way to rethink the entire-- I mean, the goal is to have cooked food. Is there a way to rethink how you get cooked food at the end of the day that avoids lifting a heavy pot from the sink.

AUDIENCE: Have a longer hose.

AUDIENCE: That's another way to do the filling right?

PROFESSOR 5: You can imagine filling it with like small-- you know, a ferry system of smaller things that get added a little bit at a time.

AUDIENCE: Or an interesting pump [INAUDIBLE].

PROFESSOR 5: If you can sort of train him how to do the task. I wonder if there are experts out there in the world that figure out how to do this. Disabled cooking, is there such a thing? But I admire you for taking it on. It just seems really hard and dangerous.

PROFESSOR 4: Great, thank you, Team Don. Thanks again. We managed to get through them all. We have maybe two or three minutes left. Maybe I'll ask if the panelists or the support staff have general comments on all the presentation today, for the panelists here today. And Professor Miller, if you have general comments or advice on the presentations or the project progress in general, give you the opportunity to do that.

But while you think about that, just one reminder is to remember to upload your slides from the presentation today, so that we can integrate these things into the video, and so that we can look at your slides as well. And then the reports are due Friday, and then next week, we'll have read all the reports, and we'll give you some more written feedback, a letter grade at this point in time.

But I'll of the panelists, Jose or Anna, Professor Leonard, Professor Miller, if you have any general comments or advice for teams at this point in time.

- PROFESSOR 1:** Great to see the progress that you're making. Keep meeting with your clients, and focus on trying to finish that prototype that you're going to deliver at the end of the semester.
- PROFESSOR 5:** I would just say, like I've taught design classes and mechanical and ocean engineering, and it's really challenging when the schedule crunch at the end of the semester, and so sometimes you're going to have to down scope towards the end. But if you try to really think about a measurable result, that you really accomplish something, and what that would be, and make sure you at least get that far. Like it would be a disaster if you didn't at least do x. What is x? Have a prototype that does something, that gives some value to your client. And so the time's going to go really quickly, and you're going to run out of time.
- PROFESSOR 6:** I would say it's great to that you all are meeting what seems like a regular basis with your collaborators for these projects. And so take advantage of every time you're meeting with them to bring something you can hold in your hand that is going to impact the final design, whether a potential material you could use, a prototype of a looks-like design, or this is a feature design. But that'll really help you to continue to iterate on those features.
- AUDIENCE:** I would echo Professor Leonard's comments of take something. If you're going towards the end of the semester, pick that one item that you know is going to make a critical difference. If you spend too much time picking pots, we know what pots look like, and how they behave. But if you don't know how another mechanism that you're designing behaves, then focus on that one. And just in case you do run out of time, you know that that's an addressable thing to leave out. Don't leave out the [? core ?] [INAUDIBLE].
- PROFESSOR 4:** Michelle, [INAUDIBLE], Grace, you have general comments? OK, cool. I think one thing I'll say is I think you all have gotten to know your clients really well, from the presentations. On Monday and Wednesday and on Friday night or on the weekend, Grace and I watched all the videos that were submitted. We're all very impressed. You really have spent a lot of time and really gotten to know the people.
- One thing I would suggest is you really, maybe in the next couple weeks, really, really get to know the client's task. I mean really break it down and come up with these measurable metrics, try things out, food color the water, things like that, so you can really get a sense of whether your device or whether the system you're building is going to work.
- PROFESSOR 5:** Like really put yourself in their shoes.

PROFESSOR 4: OK, I think that's pretty much it. Next week we're going to do a bunch of electronic device labs, so bring your laptop computer is what we're hoping for people to bring. Grace, you have a final announcement?

GRACE: Yeah, we sent out a poll today. We're going to set up twice weekly hobby shop office hours. So if you think you're going to be using a hobby shop or building anything mechanical, please fill out the-- we'll decide by Friday what those office hours are. Thanks.

PROFESSOR 4: And Monday's class lecture and lab will both be in this room because we're doing these electronic device access labs, so 32044 at both 1:00 PM and 3:00 PM. OK, thanks.