An Appliance for Individual Well Being

Mechanical Engineering 310 Fall Quarter

Team Our Team Name
Person One, Person Two, Person Three, Person Four
Person Five, Person Six, Person Seven, Person Eight

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1 Executive Summary

Embraer, the Brazilian airline manufacturer, decided to partner with Stanford University and the University of Sao Paulo to approach this problem of improving the entire air travel experience for persons with limited mobility or disabilities. The team from Stanford University is composed of two students and the university of Sao Paulo team is composed of 4 students, all with engineering degrees. In collaboration, we started this journey toward a solution through extensive needfinding and benchmarking. The needfinding centered on conducting user interviews for both the disabled passenger and the flight crew while benchmarking focused on analogous situations, patents, regulations, and current concepts and solutions.

The research that was conducted during needfinding and benchmarking was instrumental in the approach we are taking toward a solution. The user interviews led us to the five themes we need to address with our future solution. These themes are customer service, control, independence, seat preferences, and non-discriminatory. Figure 1 1 shows the themes and how they each rely on the others to be successful. The interviews with potential users revealed horror stories that dealt with customer service or the lack thereof. The solution space needs to create an environment that limits the interaction between the flight crew and the passenger to prevent these horror stories from becoming a reality for future travelers. Independence and control were also instrumental in our findings. The users of our solution want to feel independent and in control of their situation even though they might need assistance. This leads our solution path to one that centers on automation and allowing the user to control their surroundings instead of the other way around. One major discovery we made concerned the seat that a person with limited mobility chose when boarding the flight. They chose to sit in the window seat instead of the easier-to-access aisle seat to accommodate other passengers, not themselves. This brought us to the idea of making every seat accessible for all passengers regardless of mobility status. The final theme motivating our solution is a non-discriminatory design. Limited mobility passengers and passengers with disabilities have a condition that singles them out to begin with so why should our design add insult to injury by singling them out more? Therefore, we are focusing on a universal design that would aid and improve the experience for both the limited mobility passenger and the average passenger.

These themes were our driving forces for the critical function and critical experience prototypes we created to further explore our problem space. The team created a number of prototypes but really focused on the ones that solved this problem; one being a more incremental fix while the other addressed a more futuristic cabin. The incremental fix was a swivel chair that would address the window versus aisle debate in the Embraer cabins with rows of 2 seats. But what if we wanted to apply our solution to larger cabins? We then looked at a more futuristic design, which came in the CFP of seats of rails. Figure 1 2 shows the concept of the seats on rails in a clay mock-up. Here, the rows will move forward and back to provide a certain row with extra room to allow a passenger to get in and out without disturbing the other passengers. This concept brought light to all the solutions that could be implemented and what we could make the design space to be.

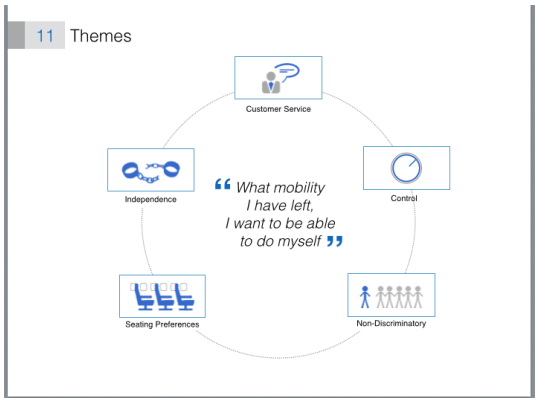

Figure 1.1: *Main themes driving our solution*

Our vision for a solution is a more dynamic cabin that allows the user to customize the space to his needs and allows for a more enjoyable and interactive experience. If the world we live in is dynamic, then why does the airplane cabin have to be static with the same seating arrangements in all planes? This is what we want to change. We want to change the way a passenger looks at the flying experience and how they feel before, during, and after the flight. The passengers should have more control over the seat selection, the firmness/softness of their seat, the angle, and the orientation; this list is endless. Giving passengers more independence and control while minimizing customer service interaction and discrimination is our motivation for a futuristic cabin that will make the entire air travel experience from home to gate to destination out of this world.

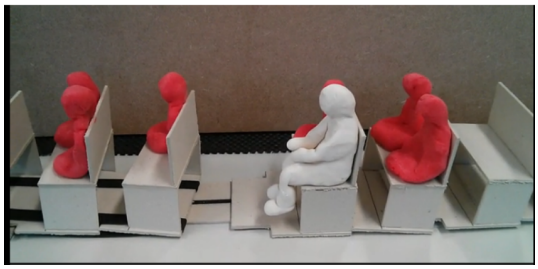

Figure 1.2: *Scaled mock-up of seats on rails prototype*

Glossary

- **ADA:** Americans with Disabilities Act; one of America's most comprehensive pieces of civil rights legislation that prohibits discrimination against and guarantees people with disabilities have the same opportunities as everyone else to participate in the mainstream of American life.

- **Assistive Technology:** Assistive, adaptive, and rehabilitative devices for people with disabilities; promotes greater independence by enabling people to perform tasks

that they were formerly unable to accomplish, or had great difficulty accomplishing.

- **Benchmarking:** A standard by which something can be measured or judged.
- **CEP:** Otherwise known as a Critical Experience Prototype, this is a physical prototype created to make an experience real enough to gather insights and understanding about the users experience.
- **CFP:** Otherwise known as a Critical Function Prototype, this is a physical prototype built to test a concept that is critical to addressing the problem statement.
- **Control:** The power to influence or direct either people's behavior or the course of events.
- **Dark Horse Prototype:** A device created during the winter quarter of ME310 that was ruled out in the fall quarter or undiscovered due to being too risky or to difficult to complete; emphasizes creative out-of-the-box thinking and exploring all of the design space for the project.
- **Disability:** A physical or mental condition that limits a person's movements, senses, or activities.
- **FAA:** Federal Aviation Administration; United States national aviation authority whose mission is to provide the safest, most efficient aerospace system in the world, oversees all aspects of American civil aviation.
- **Herrmann Brain Dominance Instrument (HDBI):** Illustrates and explains the way a person prefers to think, learn, communicate and make decisions. It identifies the preferred approach to emotional, analytical, structural, and strategic thinking.
- **Independence:** Freedom from outside control or support.
- **Limited Mobility:** Mobility impairment may be caused by a number of factors, such as disease, an accident, or a congenital disorder and may be the result from neuro-muscular or orthopedic impairments. It may include conditions such as spinal cord injury, paralysis, muscular dystrophy and cerebral palsy. It may be combined with other problems as well (i.e. brain injury, learning disability, hearing or visual impairment).
- **Needfinding:** Discovering opportunities by recognizing the gaps in the system or the needs.
- **Non-Discriminatory:** Fairness in treating people without prejudice.
- **Pain Points:** A level of difficulty sufficient to motivate someone to seek a solution or an alternative; a problem or difficulty.
- **Perspective:** A particular attitude toward or way of regarding something; a point of view.
- **Self-Image:** The idea one has of one's abilities, appearance, and personality

- **ANAC:** Agencia Nacional de Aviao Civil Brazilian National Agency of Civil Aviation
- **Libras:** Brazilian Sign Language

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Glossary

3d audio technology Simulation that creates the illusion of sound sources placed anywhere in 3 dimensional space, including behind, above or below the listener.

action-event control Process where a user action creates an physical event.

API Application Programming Interface.

array of microphones Microphones linked together to expand the effective coverage area.

Ausim 3D audio hardware company.

Automatic beam steering Signal processing technique to narrow the microphone coverage area. Used to pick out a speaker and suppress background noise coming from directions other than that of the speaker.

Benchmarking A process of researching and observing to understand the state of the art for a given field or topic.

Brainstorming A process by which groups of people generate ideas

Brainwaves A common term that refers to post-synaptic potentials measured from many neurons in the brain

CDR Center for Design Research at Stanford University

CFP Otherwise known as a Critical Function Prototype, this is a prototype built to test a concept that is critical to addressing the problem statement.

Client Computer program that accesses a server.

Client-server paradigm A computing architecture which separates the client from a server over a computer network.

Crowded channel A communication channel that is clogged with information.

CVE Acronym for Collaborative Virtual Environment. This is a virtual environment that support more than one user at the same time.

Dark Horse An idea that is unlike the others preceding it, an outlier.

It's a sign of a successful team that the glossary becomes extensive. Define any non-obvious or invented terms. For example, if you reference something by an acronym, that might be a glossary term. Teams also coin terms to describe design features. Define such terms here. Don't define obvious stuff (axle, keyboard).

See comments in me310report.tex if you want to generate a glossary semi-automatically from tagged keywords.

2 Context

2.1 Need Statement

Airlines are always searching for new ways to get more people on a flight and more money per flight, making the seats in the aircraft smaller and closer. As the seats get smaller, the personal space for a passenger shrinks, making it harder for anyone to move and fit comfortably as shown in **??**.

Figure 2.1: *With Airlines adding more and more seats to their planes, it is increasingly harder to maneuver around the cabin. Source: http://www.examiner.com/article/airlines-may-charge-fat-people-higher-fares*

With the emergence of global business, people are constantly on the go today and airports are becoming larger and larger, growing more busy each year. The distance from check-in to gate is increasing as more airlines expand routes and terminals grow. As the airports grow, it becomes harder to make the travel distance between check-in and gate short and quick. Therefore, it becomes a problem for passengers that have a hard time walking long distances or need assistance with bags or a wheelchair. More airport staff is needed to move the passengers with assistance needs, and often the staff is not trained in dealing with disabilities. Airlines have such limited space in the cabin because of the increased amount of seats that the assistive devices have to be stored in the cargo hold, making them susceptible to damage. The flying experience today is tailored to a person that has all of his/her mobility, leaving out those who do not have the mobility or have some impairment that requires additional time. However, 58 million Americans live with a disability, including 5.5 million military veterans. []

Would it not be great if the flying experience were individually tailored to a persons needs? What is the cabin could be redesigned to improve the flying experience for the passengers with limited mobility as well as for the average passenger? Such design would create an experience that is comfortable; making the airline and aircraft manufacturer more popular among its customers because the final user, the passenger, is the one the plane is designed for.

2.2 Problem Statement

To make this problem more tangible and approachable, we broke the project into different focus areas:

- Current systems in use in the airport and on the airplane
- Users Needs
- Users Complaints
- Identification of Critical Users

The whole process (see Appendix Diagram A1) was analyzed and current systems that are in use based on FAA and ADA regulations were researched to determine the gaps in the system. The gaps helped identify possible user needs. In addition, user interviews were conducted to determine more needs and used to focus exact needs that we could address with our solution. The interviews enlightened us with complaints that the current users had and ideas on where possible innovation areas lay.

For our problem, two distinct groups of users were quickly identified, the flight crew and the passengers with limited mobility. The passengers with limited mobility were a very straightforward user group as it was identified in the problem statement. However, the flight crew is the user that will have to use the solution on an everyday or every flight basis. Therefore, the ease of use and the inclusion into the flight crew tasks have to be considered in order to make the solution a success.

2.3 Corporate Partner: Embraer

The corporate partner for this design project is Embraer. Since 1969, Embraer has been involved in all aspects of the aviation field. Embraer began with support from the Brazilian Government to produce military aircraft in addition to its small passenger planes. Embraer then expanded to agricultural planes and later to commercial planes and business/private jets. Embraer has over 5,000 aircraft operating in over 80 countries. They are the market leader for commercial jets with fewer than 120 seats. Embraer is interested in expanding its commercial market to larger commercial jets, in maintaining some of the best executive jets, and in entering new defense markets.

Corporate Liaison

Luciana Ribeiro Monteiro
Technology Development

Embraer - SJK
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luciana.monteiro@embraer.com.br

2.4 The Design Team

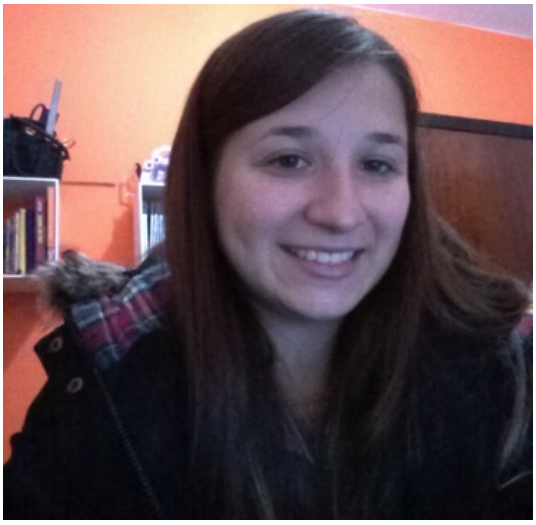
Team Embraer was assembled using the results of the Herrmann Brain Dominance Instrument (HBDI) to determine compatible thinking styles and personality traits. Additionally, our team has a diverse educational, cultural, and social background that encompasses many skill sets and multiple areas of study.

Stanford University

Maria Barrera Status: M.E. Graduate Student
Contact: mariab8@stanford.edu
I was born in Colombia and moved to South Florida with my mom when I was 10. My dad and sister still live in Colombia so I tend to hop back and forth every chance I get. I did my undergraduate at Stanford also in Mechanical Engineering and have developed a deep interest for entrepreneurship during my time here. I run a tutoring company in the area and hope to one day start a company in the aviation sector. I am also enjoy traveling, photography and playing with puppies.

Erika Finley Status: M.E. Graduate Student
Contact: erikaf@stanford.edu
I was born and raised in Tennessee. I attended the University of Tennessee at Knoxville for my undergraduate degree in Mechanical Engineering. I participated in a study abroad in Canberra, Australia. I have interned for Tennessee Valley Authority at Browns Ferry Nuclear Plant and for Schlumberger at the Rosharon Design Center. I will be interning at Microsoft this upcoming summer. My interests include baking, reading, photography, and roller coasters.

University of Sao Paulo



Amanda Mota Almeida Status: Product Design Graduate Student
Contact: amandamotaalmeida@gmail.com
I was born and raised in So Paulo. Im attending the University of So Paulo for my undergraduate studies in Product and Graphic Design. I have worked in a project with Embraer in the past regarding the design and comfort in the aircraft cabin (2011), I have interned for Staples in So Paulo SP (2012) and I was part of exchange in Portugal last year (2013). My interests include: photography, arts and crafts and reading.

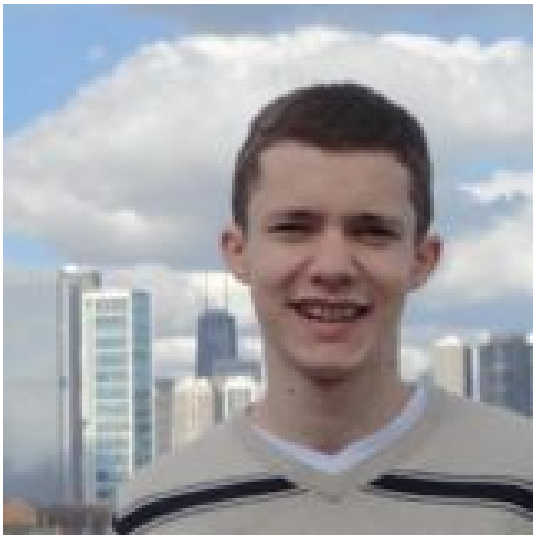
Rodrigo Monteiro de Aquino Status: Computer Engineering Undergraduate Student
Contact: guigonyts@usp.br
I have lived all my life in Sao Paulo. I am now graduating in Computer Engineering at USP and I also work in a technology development lab at the university. I have worked on several projects developing educational games and other educational interfaces that help children

Figure 2.2: *With Airlines adding more and more seats to their planes, it is increasingly harder to maneuver around the cabin. Source: http://www.examiner.com/article/airlines-may-charge-fat-people-higher-fares*

learn with technological devices. I like to play videogames and go to the movie theater. I like science fiction movies and reading adventure books.

Luiz Durao Status: Industrial Engineering Undergraduate Student
Contact: luiz.durao@usp.br
I was born and raised in So Paulo city. I attended Colgio Etapa for my High School and it was while participating in the Chemistry and Physics Olympiads that I discovered my taste for the sciences. Im attending the University of So Paulo for my undergraduate studies in Industrial Engineering. I have interned for GE Oil and Gas at Jandira SP and I have worked since my sophomore year as a teaching assistant for some courses at USP. My

interests include soccer, music and movies.



Guilherme Kok Status: Industrial Engineering Undergraduate Student
Contact: guilhermekok@gmail.com
Brazilian and a soccer enthusiast, I grew up in Sao Paulo and in Baltimore. Ive also spent 5 months in Nanaimo (Canada, BC) and 1 year studying at the University of Illinois at Urbana Champaign. Im currently finishing my undergraduate studies at the University of Sao Paulo in Brazil, where I study Industrial Engineering. I have interned for a taxi app startup and have done undergrad research concerning the consolidation of the phonographic industry. My interests include playing soccer, hiking, tasting different cuisines and travelling, preferably to remote locations.

2.5 Coaches

a) Shelly Goldberg
Contact: shelly.goldberg@gmail.com b) Annika Matta
Contact: annikamatta@gmail.com

3 Design Development

3.1 Brainstorming

The problem statement provided by Embraer gave a great deal of direction to our brainstorming sessions including the two parts of the team (Stanford and USP). The design space concerned two potential users: limited mobility or disabled passengers and the flight crew. The need-finding and benchmarking phases began with looking at the perspective of the disabled passengers and what is out there for them in the current system. The flight crew perspective brought restrictions on the design space by limiting the system to being controlled by the flight crew and fitting to their needs and motivations as well.

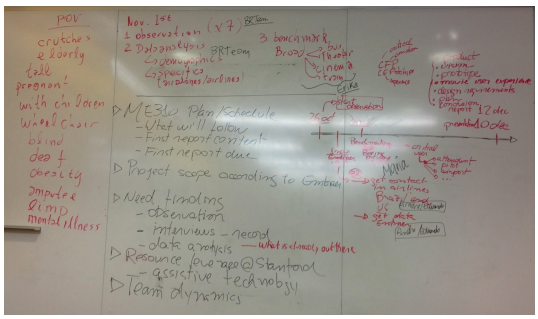


Figure 3.1: *Initial brainstorming with the whole team (USP and Stanford).*

The first brainstorming session was held with our global team during global kick-off week. Figure 3 1 shows the product of the first session and the task assignments for each team. The session focused on the first deliverables that were due, who the potential limited mobility passengers could be, what places could be researched for benchmarking, and the data that could be useful to justify persona and potential users.

The second main brainstorming session centered on determining the entire system of the flight experience and what sections could be improved the most. Figure 3 2 shows the brainstorming session in progress. This session utilized sticky notes to determine mandatory and optional activities that needed to be addressed within the design space. This was the final brainstorming session that was held jointly with both team parts. The USP and Stanford team members all worked together to develop the chart composed of sticky notes in Figure 3 3, which addresses every aspect of the travel experience from leaving home and arriving at the airport, going through security and getting to the gate, getting food and drinks while in the airport, using the restroom, boarding the plane and the in-flight experience, and finally baggage claim to final destination.

The remaining brainstorming sessions took place in more conversational format with note taking. The notes were centered on the interviews and individual research each team member had conducted.

Figure 3.2: *Brainstorming session used to map out entire flying experience.*

3.2 Communication

The communication for our team is done primarily through two main channels. First, we have weekly Skype meetings to discuss what was done within the last week and what needs to be done for the next week as well as to present future deliverables. Our second mode of communication is Podio, an online work platform for collaboration and project management where we can assign tasks, discuss projects, upload files, share findings, and communicate with status updates. These software tools allow us to keep all the major findings in one place and allow us to share what we are doing real-time. Common applications such as Dropbox, Google Docs, and Google Forms are also being used as need be to share ideas, findings and important documents.

3.3 User Benchmarking and Need-Finding

The first deliverable of the fall quarter concerning our corporate project was the benchmarking and need-finding deliverable. Current systems and technology were to be researched to see what is available to complete the benchmarking task. User interviews and user personas were to be conducted and developed, respectively, to inform our team and audience on what needs our solution needs to be addressing.

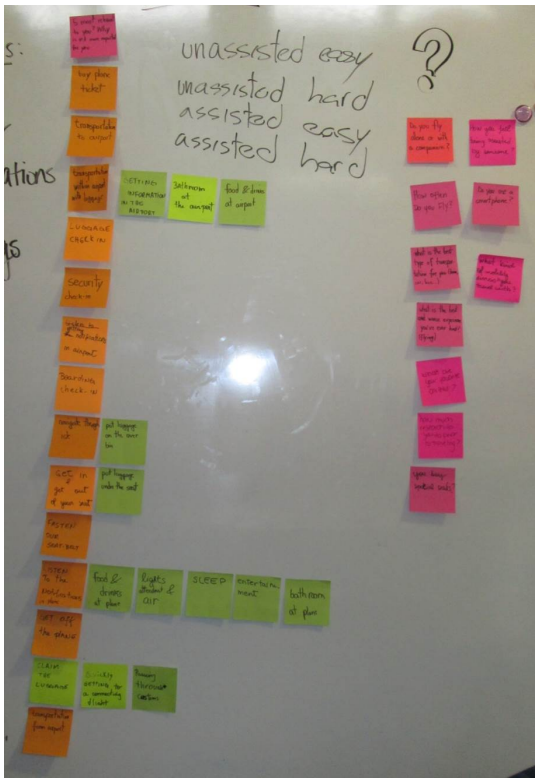


Figure 3.3: *Completed brainstorming displaying every step of the flying experience.*

3.4 Need-Finding

The solution to a problem needs to address the gaps that exist within the current systems. In order to find these gaps, our team had to extensive need finding by conducting user interviews with different potential users as well as experts in the field. Each interview gave us some more detail into who our user would be and how to go about developing our personas.

3.4.1 Expert Interviews

To begin the need-finding process, we wanted to investigate what research projects had been pursued within the aerospace industry. Two experts, one from Boeing and the other from Oregon State University shared their work experience and its motivation with us.

3.4.1.1 Dianne McMullin, Human Factors Engineer at Boeing

Dianne McMullin is a technical fellow in Human Factors Engineer at Boeing and worked on the 787 Assistive Technology Design. She has been working on this problem for over 15 years. Since she is currently working on a project with Embraer to better the flying experience for the aging passenger, she had a lot of fresh knowledge that proved to be very

relevant to our work. She shared with us some of the major restrictions we need to be conscious of such when designing something for the airline industry. These include:

- Maintain the number of seats. Airlines, and consequently airplane manufacturers, want the maximum number of seats possible to maximize profit.
- While in the air, space is more expensive than most expensive real estate in Tokyo, minimizing size is paramount.
- Weight is a critical factor, a solution cannot significantly add weight to the aircraft.

She was also able to share with us some touching points that she had encountered in her research and work. These two aspects made the team think about our users in a new light and helped us empathize with the situation and feel the pain.

- The utter sense of despair and helplessness when cane/crutches is taken away.
- Not traveling can mean not seeing kids or grandkids, missing weddings and vacations. It literally means giving up a piece of their life. Making this a better experience can, in essence, give back a little piece of that.

3.4.2 Kate Hunter-Zaworksi, Director of National Center for Accessible Transportation

Kate Hunter-Zaworski is the Director of the National Center for Accessible Transportation and also worked with Boeing on the 787 Assistive Technology Design. She was able to give us some more places to contact, interesting facts that could be used to implement a design solution, and areas to start brainstorming. Below is some of the food for thought she left us with:

- When considering the possibility of tying down wheelchairs within the cabin, the wheelchairs impact capabilities are of prime concern. However, some wheelchairs are able to stand up to 20Gs while airplane seats can only support 16Gs.

- Folding canes and other mobility aids that can be stored within the cabin and remain accessible are interesting solutions to consider.
- Why cant you maneuver a wheelchair with only one hand?

3.4.3 User Interviews

User interviews were used to really get a sense for what the user experience was, allowing us to no longer rely on our own assumptions. Given that the problem statement does not state a type of disability to focus on, we strived to encompass as many different types of disabilities as possible, looking for overlaps within the experiences. The interviews not only gave us insight into where the pain point lie but also humanized the problem even more for us. Being able to talk to these users who both have to deal with these issues on a daily basis but are also invested in helping others navigate the traveling process was extremely rewarding. Their passion for the subject refueled our own.

Wheelchair Users

The motivation behind these interviews was to find areas where corrective actions can be implemented during the travel experience for a person in a wheelchair.

3.4.3.1 Teri Adams, Assistant Director of Stanford Office of Accessible Education

Teri Adams is the Assistant Director of the Stanford Office of Accessible Education. She is an avid traveler and utilizes a power wheelchair every day and a manual wheelchair on trips. She used to travel with her power wheelchair but stopped after having several instances where her chair came back from the cargo hold broken. The following are the main areas she highlighted within her interview:

- Highlighted the persistent problem of wheelchairs being broken, both in her experience as well as her friends'.
- Described the aisle chair used to move wheelchair users from their wheelchair into the airplane seat if they cannot do it themselves. It is an incredibly degrading and embarrassing process, as shown in Figure 3 4 because the chair is not designed to fit an average sized person. Usually the process takes place before boarding begins.
- Addressed the important issue of customer service's impact. The most dramatic horror stories she had came from a lack of training or knowledge from the flight crew.
- Enlightened us on the reality of seat preferences. We assumed that people with disabilities would always choose to sit by the aisle due to the ease of access but actually found that many prefer to sit in the window seat so that they do not have to get up and down every time someone from their row needs to walk around the cabin. This is something that was completely new to us.
- Emphasized the difficulty of reaching the controls while in flight and the need for a more accessible and intuitive placement for them.

3.4.3.2 Scott Rains, Travel and Cruise Specialist for Disabled Persons

Scott Rains is a paraplegic who is very passionate about the subject of disables traveling. He is a travel and cruise specialist and an avid travel blogger, providing a community of people with disabilities with tips on how to best navigate using the current solutions out there. He travels multiple times a year for work and pleasure. Scott was kind enough to connect us with multiple contacts that we were able to reach out to due to his wealth of knowledge on the subject matter. The following were the main points that he stressed needed to be included in our design solution:

- Surprisingly, hinged armrests are not the standard. There are many aircraft where they are not present, making the transfer of a disabled passenger infinitely more

Figure 3.4: *Nicole Lemelle has Multiple Sclerosis and needs ad aisle chair to board the plane. Source: http://www.mynewnormals.com/aisle-chair/*

difficult. He recounted a friends experience of getting bumped into the armrest and needing to spend 2 weeks in the hospital as a result of the sore caused by the bump.

- Even if hinged armrests are present, the hinges are often hard to find and the flight attendants are not familiar with how to operate them. It follows with other accessibility features such as additional seat belt extensions for lumbar support.

- All disabilities are different and thus they need different things. Wheelchair users often have customized cushions or seat pads that allow for more comfort. This type of solution should also be implemented in long duration flights. If people bring their own neck pillow, why not their own butt cushion?

- Reemphasized disabled passengers wishes to sit in the window seat also for the support the wall provides as well as not wanting to be disturbed when others need to walk

around the cabin. Lack of accessible controls was also mentioned.

3.4.3.3 Jose Luis Naranjo, T6 Paraplegic

Jose Luis Naranjo is a 28-year-old T6 paraplegic. He studied engineering at MIT and now works in the bay area as a mechanical/aerospace engineer. He gave us his view of the situation and applied his engineering knowledge to help us brainstorm other solutions. His focus points were the following:

- Wheelchair storage in the cargo hold is extremely poor, they literally just throw the wheelchairs in there which allows them to shift around during flight. Very often chairs are broken.
- Flight crew also does not know how to operate the wheelchairs and have tried to fold a non-foldable wheelchair before, resulting in damaged wheelchairs.

- He uses the aisle chair very often and has noticed that because the center of gravity is very high on the aisle chair, its very easy to flip over and there is little sense of control.
- Sometimes only one side of the airplane has folding armrests.
- Boarding processes are extremely rushed, the flight crews main priority is to get the plane out on time which has a huge impact on how much time they spend with the disabled passengers that need assistance.
- Keeping track of belongings is extremely difficult, you must rely on a flight attendant to carry your luggage and then remove all loose items from the wheelchair prior to storing it. This lack of independence and control over ones belongings is nerve-wracking.
- He is a frequently traveler and thus is aware of the preparations he must ensure before each flight, especially assuring that he does not have to use the restroom at any point.
- A solution must allow for people to do as much as they can themselves, returning that lost sense of independence and control. What little mobility I have left, I want to use.
- A solution must ensure that disabled passengers are not being segregated from the rest of the population. They already know theyre different, they dont need to be reminded. Inclusivity is key.

3.4.3.4 Cid Torquato, Municipal Department of People with Disabilities and Reduced Mobility

Cid Torquato is the Coordinator at the Municipal Department of People with Disabilities and Reduced Mobility in Sao Paulo, Brazil. He is paraplegic, and constantly travels to

several countries due to his responsibilities in the department. The main points of the interview are as follows:

- There are many difficulties applying the law, people simply do not want to follow it.
- There is a lack of proper training (and even good will) for many people involved in the flight experience.
- There are some alternatives to the use of bathrooms for people with reduced mobility, including drastic ones like using a catheter to collect urine, diapers or even plugs. Due to the discomfort of using these solutions, people still prefer to use the airplane bathroom.
- Usually, security will just use the hand metal detector and will not ask for the disabled to get up off the wheelchair. However, the interviewee had an awful experience during one of his travels where they forced him to do so, even though he cannot move. He had to make his companion make a space between his back and the chair to show to security there was in fact, nothing to hide.
- Some airlines use contractors to handle people with disabilities, where trained people help with transportation and other needs of the passenger.
- There is a lack of precise information about what can or cannot be done while boarding a reduced mobility passenger. Sometimes the airline does not allow the passenger to take his/her own wheelchair through the jet way to they airplane, stating that only the airport wheelchair is allowed even though the common procedure is to pull up at the front door of the airplane and change into the aisle chair.

3.4.3.5 Nanci Linke-Ellis, Board of Trustees for HLAA

Nanci Linke-Ellis is on the Board of Trustee for Hearing Loss Association of America and is a deaf traveler. She was able to give us more information about where corrective

actions could be applied in the travel experience specifically concerning the deaf passenger. These are some of the problems she brought to our attention more than before:

- The customer service element is absolutely huge and causes a great deal of problems. Once, she approached the gate agent to inform her that she was deaf and would need to be notified of any announcements. The gate agent then asked her if she needed a wheelchair. Flight attendants do not know how to react or are uneducated about dealing with persons with disabilities.
- As a disabled traveler, it is important to make the flight crew aware of the problem but also present a possible solution.
- Planes, airports, terminals, etc. need more signage and to be more visual with instructions. This not only affects the deaf but also all passengers struggling to hear information over the loud background noise found in airports. Using a smartphone app could be an interesting solution
- Increasing independence is key.

Blind User

3.4.3.6 Cheryl Echevarria, President of NFB Travel and Tourism Division

Cheryl Echevarria is the President of NFB Travel and Tourism Division and owns her own travel agency that specializes in assisting blind travelers. She shared with us the independence that blind persons have while travelling due to advancements in education for the blind and support for the blind as well as assistive technologies that are available. She highlighted some of the main points that were already suggested by our previous interviews adding the following:

- Customer service is a major factor that can make or break an experience. The disabled person must be aware of the rules and be willing to teach uneducated flight crew about

what is allowed during flight (such as leaving your cane under your seat). Blind people would most likely not be a target user given the range of technologies already available.

3.4.4 Flight Crew

Figure 3.5: *Nikole Rubyn Virgin America Founding Flight Attendant*

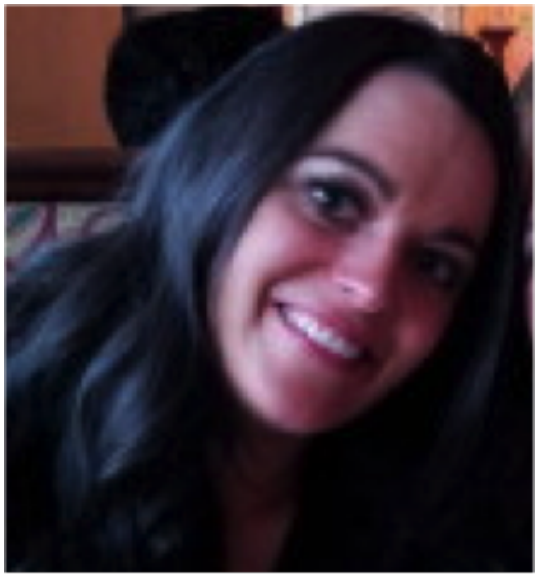


Figure 3.6: *Dena Silva-Heath Alaska Airlines Flight Attendant*

Interviewing potential users made us realize there were also other major stakeholders that had to be considered when designing a solution: the cabin crew. Not only does the cabin crew have to interact with disabled passengers on an every day basis but their actions

Figure 3.7: *Yonatan Godefa Virgin America Gate Agent*

are often fueled by motivations that can contradict providing the best assistance possible to the disabled passengers. We spoke with two flight attendants and a gate agent to get a better sense of what their pain points were, what they perceived the pain points to be for the disabled passenger and their motivations when executing tasks on the job. These findings can be broken down into two different areas of concern, the airports and the airplane.

3.4.4.1 Airport

- Not all the airports are ready to receive disabled passengers; some do not have the appropriate equipment or personnel.
- Some airports do not have enough equipment for disabled. Once, one of the flight attendants waited 40 minutes for the lift, airport elevator on the runway, to disembark the disabled.
- The aisle chair is too small for most passengers.

3.4.4.2 Airplane

- Not all the armrest are retractable, in some aircraft just the ones on the first and the second rows are.
- The lavatory is too small for the aisle chair, so often the disabled have to use it with the door open.
- For blind people they can provide the safety procedures in Braille. Little known fact, however, is that not many blind people actually know Braille.
- For deaf people there isnt any special equipment, the crew members have to speak really close so the disabled can read their lips.

- People with no chest mobility can use a special belt, but sometimes the family doesnt want it or the flight crew isnt aware of its existence.

- Paralympics athletes can usually get to their seat on their own and thus they can allow more disabled passengers on the plane when theyre flying. Usually the number allowed is one third of the number of crewmembers.

3.4.4.3 Miscellaneous

- The disabled feels humiliated for being carried thought the aisle.

- A recently disabled person is usually more dependent and more uncomfortable with the situation.

- Many people do not prepare sufficiently for the flight. They either do not have credit cards to purchase food onboard or dont realize they should go to the bathroom beforehand. The gate agents can play a role in aiding passengers prepare.

- The flight crew has another 140 passengers they must cater to throughout the flight, making it impossible for them to dedicate a significant amount of time to assisting disabled passengers.

3.4.5 Observations

In order to get a complete picture of what the traveling experience entails in general as well as how it differs for disabled passengers, our team decided to use their travels as an opportunity to delve deeper into the topic. Six different people from USP made many of the following observations on October 2013. Both the teaching team and the students travelled from Palo Alto to So Paulo (GRU) via San Francisco (SFO) or San Jose (SJO) with connections in Dallas (DFW). Most of them were on different flights and got to experience different situations. Included are also observations conducted by the Stanford team during their flight home for Thanksgiving.

3.4.5.1 Outside the Airport

- It is difficult to find a cab in smaller cities (an accessible taxi would be even more difficult).

- Walking within the city of Palo Alto was not a good experience, especially because sidewalks suddenly disappeared without any indication whatsoever. Urban planners really must take people with disabilities into account when designing urban layouts.

- Ticket vending machines at Caltrain/BART are not suited for people with disabilities, it would be extremely hard for someone in a wheelchair to reach and purchase a ticket.

- Lack of signage makes it very difficult to travel by train, especially if one has any hearing loss (or doesnt speak English fluently).

- The train and bus used to get to the San Jose airport do not offer adequate space for storing luggage near the seats reserved for people with disabilities.

- Getting in and out of the train is difficult because of the stairs and also because of the short time to embark.
- There are no people assisting passengers to embark the train/bus.
- There are not sufficient handles to hold on to on the train. This is a huge issue if one does not have perfect balance.

3.4.5.2 Inside the Airport

- There are some boarding assisting areas inside the airport and dedicated waiting lines for people with reduced mobility, as seen in Figure 3 5.

Figure 3.8: *From L to R: Boarding assistance area and dedicated waiting line*

- Finding the airline counter is not trivial, especially if one has a poor vision or is not familiar with the airport layout. There is not enough information displayed to make it an easy task.
- Check-in counters are not adapted for people with special needs.
- Conventional check-in counter is too high for a person in a wheelchair. The electronic kiosk is not user-friendly and may only be operated by a person standing and that can see. Furthermore weight scale is above the floor level, requiring somebody to lift the luggage. Assistance is provided when requested but a lot can be done to improve the process.

- Due to recent lawsuits, the Transportation Department is now requiring that all new kiosks be made accessible and that all existing kiosks must be converted within a 10 year time period. This is a huge step forward for allowing people with disabilities to have a better flying experience.

- The large mount of paper and documents required for taking a plane makes it easier to misplace something important in airport. Remember, people are normally stressed in airports.

- There are few places to wait before the security check-in and the existing ones do not have reserved seats for disabled.

Figure 3.9: *From L to R: Wheelchair with small wheels, with big wheels and for aisle*

- There are at least three types of wheelchairs like those in Figure 3 6 in an airport: those with small wheels which require someone else to push it, thus limiting the passengers independence, those with larger wheels that provide some level of independency since the passenger can conceivably wheel themselves around and aisle wheelchairs which are used for transporting passengers from a wheelchair in the jet way to their seats on the airplane.

- One is normally required to walk long distances to reach ones gate. However, the airports we visited mitigated that problem by offering solutions like an electric cart

that can carry up to 12 people (including the driver) and small buses for transportation outside the building, both shown in Figure 3 7.

- Finding the boarding gate can be a problem especially with last minute time changes, the increasing distance between gates and the difficulty of listening to the airports sound system.

- Removing all belongings when passing through security may be very difficult for some people. Although it is true that there is a special procedure for people with disabilities, the elderly did not have a special treatment. The conveyor belt is too high, making it hard to place heavy belongings on the table. Plus, there is a lot of added social pressure to move extremely fast.

- It is very difficult to understand the airports sound system over the loud background noise, even if one has a good hearing.

- Some wheelchair users have to change wheelchairs more than once in airport during check-in and boarding.

- Finding ones luggage and picking it up on baggage claim area is not as easy as one might imagine. The conveyor belt moves fast and the weight of the luggage is elevated,

Figure 3.10: *From L to R: Cart for inside transportation and bus for outside transportation*

making it hard for someone with less than perfect mobility to easily achieve the task. Most of the time, there are no employees helping.

- Although there a lot of taxis in airports, finding one that is accessible to people with reduced mobility is not as easy as one might expect. As a result, these people have to be assisted (and touched) by other people as seen in Figure 3 8.

3.4.6 Airplane Observations

1. There should be an indicator to inform passengers if overhead luggage bin is full.
2. Seat numbers should be marked more clearly because the numbers are too small.

Figure 3.11: *Obese person being transferred from wheelchair to taxi.*

3. The food tray is very slippery causing contents to go rolling all over the place during flight. A better design would include a non-slippery surface.

4. Attendant, light buttons and air control should be accessible and more intuitive to everyone. For a lot of people, it is very hard to reach all the way to the ceiling to press these buttons. In some aircraft, there is a button closer to the seat but unfortunately it is very difficult to see it. In other aircraft, the buttons are on the arm rest and get pressed accidentally all the time.

5. Seatbelts should be retractable to avoid tangling.

6. Economy class seats need to be more ergonomic to provide more comfort for users, particularly for spine and lumbar support.

7. Seats should have footrests to improve comfort for everyone and especially for shorter people.

8. The first row of seats should be more accessible to people with disabilities; the armrest should not be fixed since wheelchair users prefer to use these seats and aisle chair transfer is extremely difficult with an armrest in the way.

9. It is very difficult to understand pilot speaking in the airplane.

10. The WC was not adapted for people with reduced mobility, it was small and cramped.
11. The height of the luggage bin makes it very difficult for everyone to store and retrieve a bag, especially for shorter people.
12. A suitable place to wait to go to the lavatory does not currently exist, you are often blocking the aisle and hindering others from getting by you.
13. It is not possible to walk through the aisle when food is being served because of the dimensions of the cart/aisle.
14. Attendants dont provide enough time to eat.
15. Seats are not designed for children.
16. There are no proper areas do dispose trash while seated (unless a flight attendant is walking by with a trash bag).
17. In the lavatory it is not clear where each type of trash should be disposed where.
18. The seat is too high for people with a short stature.
19. The seat is too tight for obese people.
20. The conventional seat belt is too tight for obese people. Flight attendants need to offer seat belt extensions but a lot of them arent even aware they exist.

In order to represent the key observations in a more visual manner, the diagram represented in Figure 3 9 was created. A magnified version can be found in the Appendix Diagram A2.

Figure 3.12: *Key observations diagram*

Persona Development

Our persona development was driven by our want to always keep the end user in mind. We recognize that this is a very human centered problem and want to ensure that we keep the human centered approach every step of the way. Through our interviews, observations and need-finding processes, we discovered our solution would actually have two critical users with very different problems and motivations. These users are Patty White, the grandma, and Juliette Fields, the flight attendant.

3.4.7 Patty White, The Elderly Passenger

Figure 3.13: *Patty White, one of our design personas*

We based Patty White, shown in Figure 3 5, on a compilation of characteristics from both our interviewees as well as characters in their stories. She is an older adult in her early 60s that has limited upper body strength and mobility. She is from Cleveland, Georgia and is a retired teacher. Her southern charm as well as her past experiences as an instructor make her a very well informed and easy going traveler, always eager to explain different rules and regulations because she is keen on helping the flight crew learn about people with disabilities. Patty is widowed and usually travels alone across the country to visit her grandchildren. For Patty, giving up on flying means giving up on family. She loves to cook and will often bring her family bags of baked and preserved goods as well as lots of toys for the kids, which means she usually travels with a lot of luggage. Since Patty has just recently been dealing with her limited mobility, she is still learning to deal with being dependent on others. When flying, she is extremely uncomfortable because of the airplane seats lack of support and she needs to use the back of chairs to balance if she needs to move around the cabin.

3.4.8 Juliette Fields, Flight Attendant

The inspiration for our flight attendant arose from our many observations, past experiences and interviews. We know that the cabin crew plays an important part in the travel experience for disabled passengers and a great deal of horror stories comes from customer service issues. Thus, portraying this critical user and keeping their needs and motivations

in mind is paramount as we design a solution. Juliette is in her late 20s, she doesnt have a family and enjoys traveling around the world. She is fairly new to the airline industry and always follows protocol, she never goes above what is already listed. She does not have much experience with disabled passengers and is completely uneducated about their needs and abilities.

3.5 Benchmarking

Analogous Solutions

Part of the benchmarking phase of this project dealt with looking into other transportation and recreational areas where solutions have been implemented to accommodate those with limited mobility. Cinemas, public buses, mobility buses, personal vehicles, tram and train platforms, and grocery stores were all areas that were examined as analogous situations to the problem we were presented with.

3.5.1 Wheelchair and Passenger Transport

Figure 3.14: *Bus ramp used to assist entrance and exit onto bus. Source: http://www.romeinformation.it/en/guided-tours/rome-tours-for-disabled/*

Public buses were researched first when looking at wheelchair and passenger transport given that public bus systems service more cities than other modes of public transportation. Figure 3 6 shows a ramp that is either pulled out or automatically released from under the doors of the buses. This creates a safer and more convenient entrance onto the bus for passengers in wheelchairs or passengers that have a difficult time making the large step onto the bus.

Mobility buses or vans and personal vehicles were also examined as the accessibility features could be similar to the airplane issue being presented. These areas allow for more customization because they are designed to meet a specific need for a specific group of people. Mobility vans and personal vehicles brought forth many plausible solutions that could be employed in addressing the problem. Mobility vans/buses, just like public buses, utilized ramps or lifts to enter the vehicle Figure 3 12 show easy-access steps on a lift with extending handles for a mobility van.

Figure 3.15: *Lift used to assist in loading process.*

Figure 3.16: *Example of an aisle chair used to get wheelchair users into the plane.*

Currently, a passenger that relies on a wheelchair will have to utilize an aisle chair like the one in Figure 3 13 when boarding and disembarking from a plane. If the plane does not have a jet way, the passenger has to be carried up the stairs on the aisle chair by two people to get into the plane as shown in Figure 3 14. A passenger accustomed to being in their customized wheelchair will find the aisle chair and the carrying process very uncomfortable, unsecure, and embarrassing as evidenced by our research and interviews. We found that a variety of lifts were found that can be utilized to lift a wheelchair into a vehicle with just a push of a button once the wheelchair is latched down. Figure 3 15 shows a lift mechanism in a mobility van. This lift mechanism raises the chair to the level of the van so that the wheelchair can then be wheeled onto the bus. This exact mechanism may not be suitable for aircrafts due to the increased height of the plane, but a mechanism that is similar and allowed for automated transfer from the platform to the aircraft could be utilized. Figure 3 16 shows a lifting mechanism for a personal vehicle. This mechanism brings the entire wheelchair into the can in a sideways position. There is no manual transfer of the wheelchair

from the platform to the car. This kind of mechanism would allow for the wheelchair to be facing in the proper direction to go down the plane aisle without the need to maneuver the chair around to the correct position.

Figure 3.17: *Wheelchair user being carried up the stairs in an aisle chair.*

Lifting mechanisms are also utilized in tram and train stations as shown below in Figure 3 17. A woman uses the lifting platform for her stroller to get to the tram platform. Women with strollers and young children can be analogous models for persons with disabilities because they require more assistance, have limited mobility, and require more room on the plane to move.

3.5.2 Wheelchair Latching

Figure 3 13 shows a specific area on the bus that is reserved for passengers with disabilities. The special area is a theme throughout most modes of public transportation beside aircraft. The specialized seating area is equipped with the mounting or latching materials needed to secure a wheelchair to the floor so the person does not slide around when the bus turns or brakes. Passengers that are mobility-impaired or have a disability that does not require a wheelchair can sit in this area, which provides ease of getting on and off the bus. The seats in this area fold up and down so that passengers without disabilities can sit in this section when it is not needed for persons with disabilities. This allows for this section of the bus to function for both groups of passengers without taking away seats.

These specialized seating areas allow for wheelchairs to be latched down. If power wheelchair or even manual wheelchair is being carried in a vehicle or on an airplane, a latching system needs to be used to secure the chair to the floor so that the chair can withstand normal movement and movement in the instance of a crash. The wheelchair in Figure 3 19 is secured on metal runners that run parallel to the wheels, similar to the runners on the aisle of the airplane. Figure 3 20 shows the wheelchair being latched to metal runners that run perpendicular to the floor. This could symbolize the latching area of a normal airplane seat that has been removed for the wheelchair. For both of these passengers, an addition has been added to the normal seatbelt to provide upper body protection in the case of forward acceleration due to braking or a crash. Seatbelt additions such as these are currently available on planes to passengers who need extra upper body support.

Safety is of the utmost importance when it comes to transporting a person, whether they are disabled or not. Therefore, the latching of the wheelchair must be done at the proper angles. Figure 3 21 shows the proper angles that need to be utilized when strapping down a wheelchair in a moving transportation medium. These guidelines could be tested and modified to meet the airplane's G requirements and space, finding the optimal position that has the best level of safety for the passenger.

3.5.3 Luggage Storage and Ease of Movement through Cabin

For passengers with limited upper body strength, which is common among passengers with disabilities, getting luggage into the overhead compartments is a great challenge. Many people who have difficulties feel that they disturb other passengers while trying to load their luggage or they are simply not able to get the luggage into the compartment. What if there was a way to make it easier to reach the overhead compartment? This is where grocery store accessibility features became an analogous situation. Figure 3 17 shows a man utilizing a standing wheelchair that comes with a lift feature. This feature allows for the person to maneuver through the store in a standing position and also reach goods from the top shelf. By utilizing a stand-up wheelchair, the chair could easily fit down a plane aisle since the person is in a standing rather than sitting position. Also, the chair allows the passenger to lift their bag into the overhead compartment with little to no effort without causing a disruption and remaining independent. We found that the need for independence is a common theme among disabled passenger. They do not want their disabilities to impede on their sense of independence. In addition, they do not want someone to think they cannot do something for themselves just because they have a disability. This idea of independence and individuality leads to the next topic of customization within analogous situations. The stand-up wheelchair could also serve as a substitute for the aisle chair that is humiliating and uncomfortable to passengers.

3.5.4 Customization and Support

Many people with disabilities have to customize their surroundings to fit their needs. For persons that use a wheelchair regularly, this could mean using cushions or additional support to fit their body and their distribution of weight to prevent sores and arthritis. Figure 3 23 shows a wheelchair cushion that consists of both gel and air inserts to provide two support systems. Cushions such as these are sometimes brought onto aircraft when a passenger has a long duration flight or knows they will be sitting the entire time. Figure 3 24 shows an entire chair structure cushion that can be used to place on a chair or on a bench. This cushion allows for back and lumbar support as well as weight distribution support, however this type of support system is seen less on a flight due to the misalignment between the seat back and the cushion back.

Researching this area led to the finding of a chair, in Figure 3 25 that was specifically designed for children with disabilities to make the seats more comfortable, more accessible, and better fitting for the child during flights. This chair provides upper body support by using neck supports to stabilize the head and neck and by using a seatbelt configuration that allows the body to stay upright without relying on the core muscles. We found this attribute to be quite appealing since many persons of disabilities lose their core muscle

strength due to lack of use and inability to exercise. The chair has two back sections to provide needed lumbar support and hip support whereas the seat portion is thoroughly padded to provide better weight distribution. The leg supports are configured so that the children's legs do not dangle the entire flight since this can lead to medical issues such as deep vein thrombosis. The exact design of this chair would need to be modified for adult disabled passengers due to different needs and a bigger body frame. However, the idea is still a feasible solution to the problem being presented. Customizing an add-on airplane chair to fit the needs of the disabled passenger would allow for the disabled passenger to feel more comfortable but would not take away seats from any other passengers.

The idea of customizing parts of a seat or a seat in general brought up a new solution area to look at including the eating trays, control boards, remotes, and pouches on the back of the chairs. Most of these items do not have an analogous situation that can be easily analyzed because they exist in personal cars and each make and model is different. However, we can use the current solutions implemented in power wheelchairs to explore options for food tray placement. Figure 3 26 shows an add-on tray to a power wheelchair that allows for a person to have a tray closer to their body or in the green zone of the body. This provides easier access and more support since the closer range activates the small muscle groups that control fine motor skills. This solution that can be used on aircraft for persons who find the back of the seat or bring-up tray not stable enough for their body type and disability or for those that find they do not have a great amount of control. This tray feature would add minimal weight to the aircraft and provide a sense of independence and control for the passenger.

Patents

3.5.5 System for integrating handicapped accessible seats into aircraft interior configurations

This product in Figure 3 22 is a handicapped accessible seat that is classified functionally as an aircraft seat. It is designed such that its width allows it to easily navigate through the aisle, thus providing the disables passenger a much better boarding experience. It is configured for maneuvering within an aircraft and docks to an aircraft floor using a typical track member having a longitudinal flange like extension and counterforces for mating with a shear plug of an aircraft seat. This patent was particularly interesting to us as we developed our vision of a more dynamic cabin environment.

3.5.6 Mobile aircraft seat-wheelchair for disabled passengers and people requiring assistance

The mobile aircraft seat-wheelchair for people requiring special assistance shown in Figure 3 23 consists of a standard aircraft seat that includes a seat (2), two armrests (1) and a backrest (3), as well as wheels (7) attached on the chassis (11), a legs rest (13), a handle (16), a motor mechanism (6) for its motion, control panels (4,5), a secure locking mechanism (8,9) for its locking on the aircraft cabin floor (15), and inputs (10) for the electrical connection between aircraft systems and access buttons (14) of the aircraft seat- wheelchair. The mobile aircraft seat-wheelchair can be used by disabled people and assistants all the way

through, from the parking lot of a departing airport up to the pick-up point of the arrival airport, including intermediate steps like boarding ramps, jet ways, lifts, shuttle buses and within the aircraft cabin during flight. In the last case, it can be used by able-bodied passengers too, if there is no disabled passenger in the flight.

3.5.7 Aircraft boarding chair

The boarding chair shown in Figure 3 29 is used for assisting passengers, most typically disabled or handicapped persons, into and out of passenger vehicles. The boarding chair (10) is sufficiently narrow to pass down the aisle of a passenger vehicle, such as an aircraft. It has a seat (12) that can move up and down to match the elevation of another seat from or to which a passenger is to be moved, or to match the elevation of an armrest over which a passenger is to be moved. Lifting handles (15A, 17) are provided for carrying the chair (10) and a person seated therein up and down stairs. Outriggers (40) are provided for extension and added stability when the chair is not in use in a narrow aisle, and means are provided for selectively locking the rear caster wheels (20) against both pivoting and rotation and against pivoting only, with the caster wheels (20) locked in a straight forward position.

3.5.8 Inflatable child airplane seat

The inflatable child seat shown in Figure 3 25 is intended for use in an airplane. The inflatable child seat also includes two side panels, each of which have at least one inflatable air chamber. Both side panels are connected to the base panel. The back panel has at least one inflatable air chamber, and is connected to the two side panels and the base panel. The back panel is disposed at an angle relative to the base panel. The inflatable child seat also has a belt configured to restrain a child in the seat. It additionally has a cavity disposed in the back panel and is configured for receiving a seat belt from an airplane or car seat for securing the child seat to the airplane or car seat. The inflatable child seat is provided with at least one port that is in communication with one or more of the air chambers and serves as the means for inflating and deflating these chambers.

3.5.9 Automatic voice/text translation of phone mail messages

There is a patent for system that proves phone mail service for customers using either conventional voice telephones or text telephone units. The system of the present invention includes a phone mail unit for receiving a message from a caller and a switch connected to the phone mail unit for receiving the message and routing it to a translation unit for translation. The system also includes a gateway for receiving a data packet, containing call information related to the message. The data packet is routed to a console in the translation unit. A control interface is disposed between the gateway and the console. The control interface transfers the data packet from the gateway to the console. A communications assistant of the translation unit receives the message and data packet and translates the message from voice-to-text or text-to-voice. The translated message is then sent back to the customer's mailbox for storage and subsequent retrieval. The translated message may also be sent to the customer's electronic mailbox, pager and/or Internet address for retrieval. This would be a useful solution when attempting to relay voice or text information to a disabled passenger.

Design Solutions

3.5.10 Air Access by Priestmangoode

The solution shown in Figure 3 31 is a removable wheelchair that fits into the regular seat on the plane. The chair is designed to be thin enough to easily fit through the aisle and is able to maneuver inside the cabin. The passenger can be transported from the outside of the plane directly to its seat without the need of the transition from the aisle chair to the seat. A solution like this would render the current aisle chair solutions useless and make for a much more enjoyable boarding experience. Additionally, the chair is designed to be autonomous which would give passengers back the feeling of independence and control they so desire. This solution would also allow for other non-disabled passengers to utilize the seat when it was not needed. The problem with implementing this solution arises mainly out of cost and weight constraints.

3.5.11 Skycare Chair by Brian Liang

The project in Figure 3 32 is a redesigned aisle chair that focuses primarily on the independent locomotion of the passenger inside the plane. The lever can be pushed and pulled by the user, which will then cause the chair to move in the desired direction. As seen in Figure 3 33, the chair is also designed to allow for a seamless transfer between the aisle chair and the airplane seat, one that does not require any outside assistance. Most importantly, the chair is collapsible, making it easy to store inside the cabin without taking up too much space. The main problem with this solution is that it assumes the user has a certain amount of upper body strength, something we found to not be very common during our interviews.

3.5.12 MAMUTH Remote module for accessible boarding by Ortobras.

The remote module for accessible boarding in Figure 3 34 is a system that connects the airport transport bus of the airport to the airplane, making it more accessible. As shown in Figure 3 35, there are two separate entrances, an elevator for disabled passengers and stairs for everyone else. This is particularly problematic given our interviewees concern over discriminatory solutions and the impact those solutions have over their self-image. This module is primarily designed for smaller flights and airports where the airplane is not actually connected to a jet way. Although it is a better alternative to picking up a wheelchair passenger by the aisle chair, it is still not a solution that meets the users needs.

3.5.13 Accessible lavatory by Yokohama Aerospace America.

The accessible lavatory shown in Figure 3 36 helps people with reduced mobility because it is designed to have more space compared to other traditional lavatories. The design incorporates various places to grip, allowing for easier transfer from aisle chair to toilet or even to just provide additional balance support. The overall atmosphere intends to transmit a cozy and calm feeling with its illumination and use of color as well.

3.5.14 Economy Seat Skycouch by Recaro to Air New Zealand

The aircraft seat shown Figure 3 37 allows for the raising of the underside of the seat which can serve two different purposes. It can either be used to hold the legs or to convert the row of seats into a small bed the seats into a small bed. If the passenger is with his/her family they can be more comfortable, and get the space they need during the flight. A disabled passenger would also benefit from the extra space as it can be used to put them in a much more comfortable position that meets their specific disabilities needs.

3.5.15 Hand Talk App

This app uses voice recognition software app to translate audio, image and text into LIBRAS (Brazilian Language of Signs). As shown in Figure 3 38, it uses an avatar named Hugo that makes the gestures that can then be shown to the person the user is trying to communicate with. However, when interviewing deaf users we actually found that most of them do not actually know sign language, which limits the reach of the application.

Sign Language Ring

This app Figure 3 39 uses proprietary software to translate sign language into audio and text outputs. Designed by the Asia University in Tokyo, it uses a software/hardware solution comprised of a bracelet and ring pair that captures the movement of the sign language and then translates it. However, when interviewing deaf users we actually found that most of them do not actually know sign language, which limits the reach of the application.

Regulations

3.5.16 Definition of passenger with disabilities:

Art. 3 Para efeito desta Resoluo, entende-se por PNAE pessoa com deficincia, pessoa com idade igual ou superior a 60 (sessenta) anos, gestante, lactante, pessoa acompanhada por criana de colo, pessoa com mobilidade reduzida ou qualquer pessoa que por alguma condio especfica tenha limitao na sua autonomia como passageiro. (ANAC, 2013)

This regulation from the National Civil Aviation Agency (ANAC) gives a definition for passengers with disabilities. According to it, any person 60 years or more, pregnant, lactating, accompanied by a lap child, handicapped, or any person that for any specific condition has limitation in its autonomy as a passenger, is included in this category. This regulation goes a step further by granting the disabled the same rights of any other passenger to the installations, transport and information.

3.5.17 Prior travelling and during the travel:

The passengers have to inform the airline of their special needs, and there is no limit of passengers with special needs on board anymore (according to the a new Brazilian regulation). As for boarding and landing, people with disabilities have to board before the others and on landing must be the last to disembark. It is forbidden for the flight attendant to carry the passenger, except in case of emergencies.

3.5.18 Companion:

The legislation stipulates the need for a companion for people with disabilities, specifically for those that for reasons of mental or intellectual nature do not understand the safety instructions or cannot use a lavatory without assistance.

3.5.19 Guide-dog:

Users with a guide dog may board with their dog without any additional fees. The dog must be next to its owner at all times, has to be attached to a leash and within its owners control, without obstructing the aisles. Feeding is the responsibility of the owner.

3.5.20 Designation of seating and restraint mechanisms:

According to ANAC (2013) the operator must provide an adequate seat for infants to stay on during flights (special seats) next to the aisle (except on emergency exits, where they are forbidden), movable armrests on the front and rear rows of the plane. They must also provide and a device that supports a passenger if he/she does not have enough strength to remain seated straight (lack of strength on the upper part of the body).

For people who cannot keep the seat on the upright position, the airline must keep the seat right behind him empty. Those that cannot flex their knee must have special seats or travel with a specific device.

3.5.21 Aircraft Configurations:

The following changes are applicable for new airplanes that will enter the Brazilian market

1. Airplanes with 30 seats or more must have at least half of its aisle seats with a movable arm rest; and

2. Airplanes with 100 seats or more must have room for at least one wheelchair on board of the cabin.

3.6 Themes

Our needfinding and benchmarking led us to the discovery of several themes that need to be addressed by our solution vision and the solution itself. Figure 3 40 shows the themes that we discovered during our user interviews.

Customer Service

The main complaint that our potential users expressed dealt with the customer service they received during the entire flying experience. The service personnel either did not have the proper training or did not show the empathy the user felt they deserved. This theme brings forth the idea that our solution needs to limit the interaction between the passenger and the flight crew to reduce the unpleasant experiences. By reducing the contact time between the passenger and the flight crew, the flight crew would have more time to deal with all the

other passengers and their safety duties as well as fulfill their number one priority, getting the flight out on time.

Independence and Control

The next two themes address the independence and control the user perceives he/she has. The solution we envision must allow for our users to keep the independence they have and allow them to feel as independent as other passengers even though they need a little assistance. The users want to have control over their environment and the situation. As one of our interviewees said, Whatever mobility I have left, I want to be able to use. The current system that is in place makes the users feel like they are utterly dependent on others and that they have no control or security over their well-being during the experience. If we are able to give them back control and independence, we will improve the user experience and the user self-image.

Seating Preferences

One of the major discoveries we made during our user interviews is that disabled or limited mobility passengers chose to sit in the window seat over the aisle seat. We expected them to want to sit in the aisle seat to have ease of entry and exit. Instead, being worried about other passengers needing to get up or move makes the limited mobility passengers have to select a seat they might not want to please others and to make them feel like they are not inconvenient to the other passengers.

Non-Discriminatory

The final theme we want to take to our solution space is making the process non-discriminatory. Limited mobility passengers or passengers with a disability know they have something that makes them special and standout. Our solution does not need to bring attention to these passengers specifically but needs to be a universal design that works for the average passenger and the passenger with reduced mobility. These five themes are the driving forces behind our solution vision and the motivations for our future solution.

The themes and the benchmarking findings opened the teams eyes to what is broken about the flying experience and where improvements can be made. In addition, we were able to design concepts that can be applied to our future solution and the futuristic cabin we are envisioning. By utilizing the analogous situations, patents, regulations, and current products, we are able to see what can be done, what is being thought about, and what we can build off to make our final solution. This is invaluable knowledge due to the importance of our project and users and the importance of making a successful product that is not on the market today.

Critical Function and Critical Experience Prototypes (CFP/CEP)

The critical function and experience prototype task is to challenge the perceptions and assumptions around a certain design idea by testing a portion or all of the design on users or by building a physical product that can show faults and improvements.

3.7 CFP/CEP Brainstorming

Based on the data we gathered through our interviews, observations and benchmarking we were able to conduct brainstorming sessions to generate ideas for prototyping. Team Stanford came up with the following ideas in Figure 3 41:

1. Swivel chair
2. Inflatable, customizable chair cushion
3. Latching of wheelchairs inside the cabin
4. Latching storage in the cargo hold
5. Automated luggage claimer
6. Standup wheelchair
7. Under-seat storage
8. Zip line down aisle
9. Elevator platform for loading/unloading
10. Conveyor belt down aisle
11. Luggage pads/conveyor belt to seat for luggage
12. Cabin storage for wheelchairs

USP came up with the following ideas in Figure 3 42:

1. RFID Wheelchair, to avoid losing wheelchairs while travelling.
2. Rotating chair, similar to Stanfords swivel chair.
3. Tactile accessible solution, to guide blinds in the airplane.
4. Seat (passenger) interaction, to make the flying experience more similar to a gathering of friends (board games, parties, conversation).
5. Obese chair, which would be a stronger chair with more space adapted to their needs.
6. Baby seat, removable seat cushion with special compartment for placing the baby while traveling.

7. Underground bin, same as Stanfords under-seat storage.
8. Blind and deaf app, to make acquiring information and communicating in airport and in planes easier for blind and deaf.
9. Sliding cushion, to avoid transferring wheelchair users in the plane.
10. Foldable chair to open space in the airplane.
11. Adjustable pitch, to make every seat on the airplane accessible.

Utilizing these ideas, we went back to our main themes and focused on the solutions that truly addressed as many user needs as possible. This thinking led the Stanford team to designing the swivel chair and the luggage carrier and the USP team to designing the seats on rails and a flight companion smartphone application.

3.8 Swivel Chair Experience and Functionality

The swivel chair idea stemmed from our finding that while we always assumed that disabled passengers would rather sit by the aisle for ease of accessibility, our interview revealed otherwise. Most disabled passengers actually choose to sit in the window because they dont or cant get up every time someone needs to get by and they really dont want to be in someone elses way. We saw the swivel chair as a potential solution to that problem.

Theme

This particular solution addresses a number of the recurring themes from our interviews. Primarily it addresses the issue of seat preferences and allowing disabled passengers to sit in the aisle if they prefer without it being an inconvenience to them or others. It also gives passengers back their sense of control and independence by enabling them to take charge when they are confronted with someone who needs to get through and giving them the ability to excuse on their own without the help of the flight attendant. Since we found that flight attendants are extremely busy serving all passengers, this sort of solution would be welcome. Finally, this product is truly nondiscriminatory. It is a mechanism that anyone could use and enjoy, even those with full mobility.

Functionality

Our motivation behind prototyping both the experience and functionality of a swivel chair was to evaluate the design challenges and limitations that we would encounter. We really wanted to emphasize looking at this design in the correct environment and took the appropriate steps to make sure that occurred. We built an aisle in our workstation and used train seats to mimic the airplane seat functionality. Using armrests from a van we got from a junkyard, we were able to create a simulation of an airplane seat that made the experience more realistic. We used the numbers provided by Embraer to ensure the various dimensions of the aisle width, seat width and seat pitch were accurate. For the actual swivel mechanism

we utilized a swivel cushion usually used for cars shown in Figure 3 43. This product has a plastic bearing inside that allows the top to rotate while the bottom remains fixed to the chair, aided by a high friction, rubber surface. Inside, two plastic covers aim to reduce the friction between the two parts, something we found wasnt enough. After building the whole environment in our workspace as shown in Figure 3 44, we also went one step further and used the mechanism during an actual flight. Both of these experiences provided us with a myriad of learnings that will continue to drive our next designs.

Lessons Learned

The biggest lesson we took away from this prototype was its need to be automated. We found that friction was a huge factor and it took a substantial amount of upper body strength, something not many disabled persons have, to perform the rotating movement. Because of the automated nature, it is also a solution that must be integrated into the actual seat to ensure that it works even if a person brings an extra blanket or cushion. This would also be necessary due to the angle of the seat, which would have great impact on the forces required to rotate the chair. When trying the mechanism inside the actual cabin, we discovered that in order for it to actually work the cabin needs to be outfitted with pivoting armrests. We assumed that this was the standard on airplanes but actually found that it is not the case, especially not in the aisle. Aircrafts must have a minimum number of pivoting armrests due to regulations and most do not go out of their way to add more. Additionally, if they do pivot, the mechanism to enable this is often hard to find and operate. This is a big barrier for our solution. However, we did find that there is enough space in the aircraft to perform the rotating motion without any tolerance problems, which was also a big concern of ours.

3.9 Luggage Pod

The idea of a luggage pod was actually inspired by a trip to the mall. After shopping for a long number of hours and accumulating a number of bags, one of our team members deeply wished for a device that would follow her with her bags. After conducting our interviews, we found that a large amount of anxiety stems from not being aware of ones belongings, whether that be luggage or disability aids. Thus, we decided to design a solution that would allow users to always keep their luggage with them without the hassle of actually carrying it.

Theme

The luggage pod addressed a number of themes that came up during our interviews. This device allows for users to regain their independence, relying on a robot to carry their belongings as opposed to a separate service provider. This is extremely valuable as the recurring pain point in our interviews was the customer service. The device uses automation to create an experience devoid of outside assistance, which would increase customer satisfaction. It also gives them the illusion of control by allowing them to set the location and distance of the luggage pod such that it always remains in their field of vision.

Functionality

We prototyped what the user experience would be like by using a dolly and tethering it to a wheelchair with a string as shown in Figure 3 45. A bin was placed on top to symbolize the bin and the users belongings were then placed inside. In order to test out the actual functionality, the Stanford team rode around the quad in the wheelchair with the dolly attached, seeking different elevations and angles to examine how the device performed. With this, we accomplished our goals of visualizing and mimicking an automatic system for transporting luggage for a disabled passenger without having to carry the luggage on the wheelchair, on them, or have another person carry it.

Lessons Learned

Through creating and executing this rough experience prototype, we gained a variety of insights. In a way our design vision was validated because we realized that an actual solution would definitely have to be both wireless and automated. Having it tethered to the wheelchair created a lot of problems, particularly if the ground was on an incline. Additionally, the device needs to be very close to the user, ensuring that the user can always keep their eyes on their belongings and reducing the anxiety of not knowing their whereabouts. The actual relative placement of the device is also if importance as it cannot be directly in front of the user for safety reasons but needs to be somewhere in peripheral sight. The actual pod needs to be secure in order to prevent any belongings from either falling or getting stolen, which is especially important in crowded airports. Finally, this pod could actually be a bag with autonomous capabilities or part of a larger solution that includes a conveyor belt that takes your luggage to your seat during boarding.

3.10 Airport Phone App

During our interviews with deaf and blind users, we found that the transfer of information in airports is extremely broken. The USP worked on developing an app that would provide users with the information they need at every step of their flying experience. The purpose of the prototype was to evaluate the important features that should be part of the app and also the information hierarchy.

Theme

The main themes this prototype addressed were those of gaining control and independence. By giving users all of the information they could ever need in their hands, this product is freeing them from having to utilize other outside resources that are often not accustomed to dealing with disabled people. By reducing the time spent with and reliance upon service providers, as well as controlling the communication flow such that only the most imperative information is relayed and prioritized, we are enabling a better user experience.

Functionality

After we developed the idea for the App we thought about making a paper prototype, yet decided that it could be more interesting to build a PowerPoint prototype that would simulate the navigation closer to reality. We tried to incorporate realistic situations into the prototype, like simulating the change of gates and the position of the user. We used apps from American Airlines and Hand Talk as references and were able to populate our first prototype with some existing data.

We simulated a passenger trying to get basic flight data and information about the airport such as the location of the restroom, the check-in area, etc. In our interviews, we saw it is very common to get lost in an airport and it is really difficult to get information, particularly when in a foreign country. Another important point to be highlighted is that this experience is even worse for passengers with reduced mobility or ability to communicate (including foreigners) because they have to make a greater effort to acquire the information they need.

Lessons Learned

This app prototype taught the team that information must be relayed in both a visual and auditory manner and all information must be recorded in some sort notification feed to ensure the passenger is always up to date. In order to make the user experience intuitive and appropriate for the environment of a busy airport, the app must have a fast reaction time and the buttons must be larger than usual, like the mock up shown in Figure 3 46. The search functions must enable quick search for restaurants, bathrooms and security to enable easy access to passengers as well as an option to check the flight information not only based on flight number but also the airports schedule. Finally, the app should have an emergency button for immediate assistance, so as to reduce anxiety in critical situations, especially when the user does not know what is going on or how to get the help they need.

3.11 Seats on Rails

The seats on rails prototype aimed to solve the same problem that the swivel chair prototype did, the idea of disabled passengers not sitting where they want to sit but rather where they think they have to. This specific idea was much more futuristic than the swivel chair mechanism, however, making it something that would have to completely redesign the cabin and the flying experience. The purpose of the various prototypes discussed below was to explore the conceptual feasibility of an airplane with adjustable seat pitches, taking into account the comfort of the passenger being moved and also the benefits of having more space to maneuver.

Theme

The idea of the seats on rails encompasses a number of the themes we discovered during our user interviews. It allows for passengers to choose where they actually want to sit without the hassle of having to get up or down every time someone has to get to the aisle. It

provides passengers with more control of the situation, allowing them to take action when they need to make room. It also increases their sense of independence because they would no longer be reliant upon a flight attendant when needing to exit the row. Finally, it is a solution that every passenger could benefit from, not only those that are disabled, making the flying experience more enjoyable for all.

Functionality

After we developed the idea of the seats on rails using the drawings in Figure 3 47, Amanda made a simple model using paper that we had that moment (Figure 3 48). This first physical model, which was made using a sheet of paper, scissors and adhesive tape, gave us a general idea of how the seats would move and provided us with an idea of what we needed for a more complex prototype.

Our second prototype shown in Figure 3 49 was made with thicker paper and used a rubber band as a mechanism to make the seats move in a synchronized manner. After fixing a couple of strings on the chairs that needed to move, it was easy to simulate a specific row gaining a lot of space reducing only a bit from every other row. In order to give a more realistic touch to this prototype we shaped clay dolls to represent sitting passengers. Using them we were able to simulate some situations, like a person wanting more space to get up and a big person trying to access the window seat. This last scenario is played out in the animation found in Figure 3 50.

The third prototype was in real scale because we wanted to see how a real person would act and feel on the mechanism in order to understand his impressions about the system. We simulated an elderly man trying to get to his seat using the actual model of the seats, shown in Figure 3 51. We started by acting out what the status quo actually feels like, having to get in to a row of seat where the arm rest doesnt go up or even where there is someone else in the aisle seat that doesnt let you go through. We were able to put into perspective the fact that the status quo can be very uncomfortable in most situations, and by using the seats on rails the issues could be eliminated. The prototype allowed the user to motion to the row when he got to his seat and the row automatically moved back to make enough space for him to comfortably get into his seat. Once the user was situated, he motioned once more and the row moved to its original position. This was done by only taking up a big of space from every other seat and would have to be implemented such that the other passengers present did not notice the difference.

Lessons Learned

Even though some of the problems our users encountered could be solved with a solution like the seats on rails, the third real scale prototype raised problems we could not see before. For example, people in the window seat may be uncomfortable if they are leaning on the window, or passengers could be confused if the ground is moving and their feet are being dragged. Thus, the floor has to move along with the seats as well as the seat numbers to avoid any confusion. This also raises the question of whether individual passengers should have control of the system or if flight attendants should, which would inevitably reduce the feeling of independence we were looking to increase. We must also take into account the

constraints imposed by emergency exits and laboratories and they will have a huge impact on the actual implementation of such a solution. Finally, the systems mechanics must be implemented such that the vibrations are extremely low and the overall system employs very subtle movements as to not detract from the passenger experience.

3.12 Main takeaways

The prototypes both of our teams created really enabled us discover interesting insights we could not have foreseen only by brainstorming and thinking about our ideas. They added a more human based approach to our design process, forcing us to really think about the user and the experience as opposed to just the technicalities of the product. Since our problem is so human centered in the first place, we must ensure that we are constantly prototyping and iterating our solution until we find the right one. They also taught us that many of the solutions we were considered are incremental but together they could be part of a larger vision for the cabin of tomorrow. The most important learning, however, is that building early and often helps flesh out ideas much more than a sketch does.

4 Vision

Vision

Focusing on the needs of an underserved and suffering extreme user will enable us to design an all-inclusive universal solution. As those with disabilities require the most dramatic accommodation, a solution that would satiate their needs in a manner that normalizes their flying experience would also better the journey for all passengers. We thus aim to empower these extreme users by enabling greater autonomy while integrating them into a normative and shared flight experience, ultimately improving the comfort, convenience, and overall experience for all those sharing a flight.

The environment of both the airplane and airport will adapt to the needs of each individual. This futuristic system will be economically viable, as it will provide increased value to customers without a substantial weight increase or a loss of available seats. This additional value will foster a greater desire to travel by air and will consequently increase the quantity of prospective passengers.

In contrast to the sardine in a can-esque experience so prevalent today, the cabin in 30 years will be universally designed and provide a unique experience to each passenger. A more comfortable layout will liberate the passenger of unnecessary and harmful movements. Furthermore, the cabins design will diminish the requisite assistance sought today to help accomplish simple tasks (such as seating or going to the restroom).

4.1 Accommodation System:

The cabin will address several pain points with a system of accommodations. For example, the seats will have adjustable pitch. This will make it easier to get in and out of the seat. Furthermore, the seats would be adjustable for different body types, thus effectively improving comfort and satisfaction for the traveler.

4.2 Seat configuration:

The seat configuration will promote social interaction rather than personal entertainment. As a result, passengers could transplant their home experience into the plane; families can spend quality time together while friends can converse and play games. Business travellers will be able to work and participate in meetings as if they spent the flight within their offices. In other words, the cabin accommodates a variety of passengers by carrying their experience from home or work into the airplane.

4.3 Micro-airports:

Airports will shrink considerably, as there will be no more need to check-in physically, check luggage or arrive three hours in advance of flights. While airplanes will still transport a

great amount of people, the boarding experience will be much like that of hailing a cab. The flight experience will be as simple as reserving a ticket, showing on time for departure, checking-in ones luggage when boarding and flying to ones destination.

4.4 The Personalized Information Era:

Information will be ubiquitous and fed in real time. Messages will be tailored to each individuals needs. The message will be transmitted with respect to the capacities of each passenger. Instead of being the era of information, it will be the era of personalized information, with accessibility and customization granted to all. This information can be brought into the cabin such that when you check in, the seat knows its you and automatically adjusts to your preferences.

4.5 The Experience

The solutions we developed are aligned with the group's vision because they seek to solve the individual problems of each user using global solutions. Thus, the flight condition is improved for all who use the software, processes and devices proposed, regardless of whether the passenger is disabled or not. When we developed a swivel seat, an application or an adjustable seat pitch, we considered that everyone can and should have access to a pleasant and comfortable experience. Each human being should have a special experience because a trip takes more than passengers; it carries dreams of a memorable tour or a successful business trip.

5 Planning

5.1 Deliverables

The official deliverables for the winter quarter focus on three main prototypes: dark horse, funky, and functional. In addition to these three prototypes, our team has set more deliverables within each one. Each prototype will have a dedicated brainstorming session after a project briefing, and two iterations of each prototype must be performed. The dark horse prototype is where we plan to address the futuristic cabin approach and bring that idea to life. We want to have the basis of our final solution started by the end of dark horse and continually increasing to the end of winter quarter. Our main personal deliverable will be to have a final solution design space and all the integral components decided before the end of winter so spring will be iteration after iteration until perfection.

5.2 Milestones

The milestones for the winter quarter are the darkhorse, funky, and functional prototypes. Each of these will represent a challenge to our design thinking and our solution space. In addition, we have the milestone of integrating two new team members into the ME310 experience and making a smooth transition. Another milestone will be the creation of our final design solution space. We will also be traveling to Brazil at the end of the winter quarter to do a prototype meeting.

5.3 Distributed team management

The entire team will be working on each of these projects and doing the documentation that accompanies each one. Each team segment will be responsible for the documentation concerning their prototypes and clearly articulating the lessons learned and the takeaways. We will also distribute the workload more thoroughly next quarter with the addition of two new team members. We plan to write the documentation in paragraph and bullet form from the beginning next quarter instead of bullets to make an easier transition. The bullet format will still be used to distribute ideas to our global team and the teaching team.

As for each team members role for the Stanford team, it has not been decided who will be the chief documentation and chief financial officers or if all the roles will be switched to accommodate the new team dynamic.

5.4 Project Budget

Below is the budget planning for the winter quarter prototypes. Iterations of designs are included in our budget to encourage testing and learning from failures. The budget is on the overzealous side and we hope to spend less than the allotted amount so that the majority of the money can be used during spring for the iterations and the final cabin experience.

5.5 Project Time Line

5.6 Reflection and Goals

5.6.1 Rodrigo

So far Ive learned a lot of new methods and techniques of doing a project. The "always prototype" methodology is a great way to visualize our ideas and learn from them as soon as possible. I enjoyed the interaction we had with our team at Stanford, it is great to interact and work with people of different background and culture. Even though we have a six hours time zone difference we were able to get synchronized quite well and our communication and file sharing was pretty effective. I believe that the in next quarters we'll learn a lot more, because new prototypes are going to be made and with the experience acquired from them we'll become closer to our solution, since we'll have a better vision of our problem.

5.6.2 Luiz

On this initial quarter Ive learned a lot of things, not only new techniques but also new ways to work and deal with different cultures. Ive learned the importance of early prototyping, which makes the relationship with the idea easier and anticipates errors, contributing thus to learning faster and reducing the total costs.

Ive also learned the importance of empathy especially when the final user is different from us, it is important to get to know the feelings of the people in order to make a good design; and the importance of setting up a good communication platform, its hard to conciliate different time zones and cultures. Another important thing Ive consolidated after this quarter is the power of working in group. Its true that we had some troubles, but working as group we get over it.

I believe that the next quarters are full with great new discoveries especially when you have in mind we still got to work on 3 or 4 prototypes. I believe Ill learn a lot about users and their needs, and with that, grow as person by being able to understand others.

5.6.3 Amanda

So far, my learning encompassed different areas. First, I was able to deepen my understanding of a new Design methodology, making the comparison with other methods to enrich the design choices possible. This knowledge can and will be use during my professional life. Furthermore, Ive learned different techniques for each stage of the project such as the execution of personas.

The fact of having a project with a large scope allowed me to better understand the life and situation of people with different disabilities. This understanding has created a new look at the restricted environment of the airplane, which made us work with a great number of contradictions. This kind of situation makes us overcome big challenges.

Furthermore the understanding of the regulations and the operation of the aircraft system was also a great learning experience.

In relation to group communication, the cultural differences, language, time zone and distance are factors that contributed to making this experience unique.

5.6.4 Guilherme

While the open-ended nature of the problem was intimidating at first, I think we have done good job in handling it and fractioning it down to specific activities instead of particular groups of people. This was particularly a great experience because it was one of the first times that I received a vague problem like this one and had to first find out what the actual problem was so that I could try to find a solution for it. I was also impressed with the learning curve that making a prototype provides. This is shocking because in four years of an engineering college, Ive only made a handful of prototypes. Therefore I believe this has been a major discovery.

Another take away that I noticed is that being in a diverse group contributes positively to the creativity of the group. I have made several projects with Industrial Engineers, but never once I saw as many new ideas as in this project. For instance, Amanda who studies Product Design, surprised me positively with her prototyping ideas, including the Claymotion one. The simplicity and effectiveness of the Swivel Chair designed by Erika and Maria also impressed me.

In spite of the communication problems we had on the beginning of the project, I believe that our team has bonded the past few weeks. We did have some conflicts throughout the semester, but I believe they are natural and sometimes welcome, because it allows us to improve. On a personal note, I believe Ive failed to consistently check the courses calendar and may have upset Maria and Erika a few times because of the lack of planning from our part. This issue should not happen again because our misbelief that we did not have to follow ME310s calendar, expect for the final deliveries, was already corrected. On the other hand, I believe we did a quality job elaborating both the presentation and documentation and Im looking forward to see our final prototype.

Looking forward to meeting our new teammates and buying them a pint (at Podio, or later on in Sao Paulo)!

5.6.5 Erika

So far this quarter I have learned a great deal in both a personal and design perspective. I have learned about my shortcomings and weaknesses and where I need improvement before I enter the workforce. But most importantly, I learned how to bring my personality to a design challenge such as the one we are being presented with. I have never been in a design course of this vigor or intensity. It has been a very eye-opening experience to all the work that needs to happen to define a problem more specifically when given an open-ended problem. The needfinding and benchmarking was very informative and showed me the lack of knowledge I have had within the world of disabilities and how they are treated. In addition, I learned the importance of team dynamics and its effect on making a successful and healthy team. My passion for design has grown from this course, and I am excited for the next two quarters. I cannot wait to see our final design solution and to help people around the world do something they love (TRAVEL!!!).

5.6.6 Maria

This quarter has been an incredible learning experience. Our team was lucky in that we got a project we were extremely passionate about and were able to recruit a team of

wonderful advisors and invested parties. This project promotes so much passion within our interviewees and it has been great to learn about the daily struggles of disabled people because we tend to take all of these normal things for granted. Ive loved working with the USP team, I have witnessed the evolution from the lost duckling to the roaring lion, at first confused as to how to proceed but now being leaders and calling the shots. Its wonderful. Obviously our team has gone through a lot but I am really excited for whats to come. The process of finding potential teammates that would be as passionate about the project as we are and would also contribute both academically and emotionally to the team was a very interesting one. I actually think every team should be forced to undergo this process because it really makes you think about what truly matters when building a team. Additionally, bringing in people from other disciplines will be extremely valuable, as they will come with their own experiences and biases to complement ours. I am excited to see what amazing things we will come up with this upcoming quarters and even more excited for the journey that takes us there (and Brazil, duh!).

6 Resources

Include lists of human, institutional and vendor resources here with contact information. This is not for direct citations, which go on the Bibliography.

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