ENGINEERING DESIGN PROCESS

Handibrella

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PREFACE

The ADA defines a person with a disability as a person who has a physical or mental impairment. This limits one or more major life activity in their everyday lives. It includes people who have a record of such an impairment, even if they do not currently have a disability. It also includes individuals who do not have a disability but are regarded as having a disability ("What is the definition of disability under the ADA?", 2019).

Disability is a major factor in today's world. This design process stemmed our passion into this project. Creating this project helps us be more involved and experienced when it comes to real world problems. Our professor, Benjamin Manning, gave us the opportunity to build this project and solve a particular problem.

We would like to thank Professor Benjamin Manning from the University of Georgia for giving us the support and guidance to this project. The opportunity of constructing on a disability is a life changing experience.

BACKGROUND

In our society there are many handicapped, disabled, or physically disabled people. Disability is one of the most important issues in today's society, and there are many people with these problems that are put in this disadvantage. A person with disability is one who is not able to do major physical or mental functions of life.

But the question is, how are some ways we, as a society, can help the disabled in these certain areas or situations? There are people who have lost the privilege to do random activities due to diseases, and there are others who may been victims of accidents or injuries. Nevertheless, disabled individuals are deprived of enjoying a normal life.

When analyzing the issue at hand, we figured it would be better to give background on the people we were trying to help. Most everyone knows at least one person close to them that are confined to a wheelchair. The reasons that people are in wheelchairs stems from multiple different reasons. Given that these people have different reasons for their disability, they also have different needs when it comes to living on a day to day basis. The point of this part of the paper is not to draw attention to our product but draw attention to the reason behind it. We wanted to analyze the backbone of what makes the product worth making. In looking at people confined to wheelchairs, we need to look at the many reasons they are confined to a wheelchair, common problems that they face, and some statistics on the amount of people who are affected.

In researching the reasons that people were confined to a wheelchair, we came across a lot more reasons than we had originally expected. We found at least 30 different diseases that could cause the need for a wheelchair and these did not even include injuries from accidents or old age. (“Medical Health Issues Requiring a Wheelchair”). In looking at a few of the reasons, several of them stand out such as obesity, paraplegic, and multiple sclerosis. In looking at obesity, while it is a problem that could be prevented, it is one of the largest issues found within the United States. Best represented by the movie Wall-E, the funny scene of the overweight people in the movie could become the truth for the world if we do not watch what we consume. The fact that it is only five dollars for chicken nuggets is part of the reason that America has this issue. In analyzing the fast food market in the United States, it can be seen that it is an $80 billion-dollar market (https://www.partnersforyourhealth.com/fast-food-statistics).

Some people face obesity due to health reasons while others are just dragged into the corrupt system that is made in order to make money. In looking at paraplegia, it can be seen that that disability can stem from multiple issues itself. These include strokes, spinal issues, genetic disorders, spinal issues, and a couple of other things. The term paraplegia is the scientific term for someone who is paralyzed from the waist down. This is the reason they must have a wheelchair as they would have no other way of getting around. If it wasn't for the wheelchair, most of these people would spend most of their time in one spot. In analyzing some of the reasons, over 200,000 Americans are paraplegic due to spinal cord issues with 2500 more issues occurring each year ("Paraplegia", 2018). While this number may seem smaller than expected, this is not the biggest cause for the disability. As seen in the same article we read, 38% of these cases stemmed from car or motorcycle accidents ("Paraplegia", 2018).

Multiple sclerosis is another reason for a wheelchair and one that is close to my heart. One of our good friends, Cole Turner, was recently diagnosed with MS. While his form is not very fast, it is still a disease that is very scary due to its lack of a cure. It eats away at all the nerve coatings in the body and can affect the brain as well as spinal system. While these are just a few of the reasons. We hope that it provides more insight into the reason behind our invention.

In looking at the many problems that people in wheelchairs face not including ours that we are tackling, it was like a complete 360 when analyzing our lives to them. While they are just regular people, they face problems on a day to day basis that we normally wouldn't even consider. Some that we realized were simple things such as showering, getting dressed, and driving. There are multiple levels of disability when it comes to people in wheelchairs. Some people in wheelchairs have limited mobility, but they are able to walk. The wheelchair is just there in order to help them, but they are able to do some tasks on their own such as transferring to their wheelchair and such. Others are confined to their wheelchair, but they are able to use their upper body with no issues. The third one would be a person who has limited movement in their upper body but no ability to move their lower body. These are most commonly the people confined to an electric wheelchair. The worst of the four of these is the people who are not able to use their upper body or lower body. This usually requires a helping hand in everything that they do.

Given that these people need to be acquainted for, many inventions have been created in order to help them with their day to day struggles. One particular example is stairs or curbs. Cities and establishments have fixed this issue with the installation of curb ramps, large ramps, and elevators. Regarding driving, cars have been made so that a wheelchair may be entered through the back and locked into the driver's seat of cars. Even on our on beautiful college campus at the

University of Georgia, we are able to see accompaniments in our buses with the “kneeling bus” feature which allows participants to be able to roll onto the bus with ease. In order for these things to be available, someone had to initially come up with the idea and go through with the building of the item.

In running some numbers on how many people are presently in a wheelchair, we were baffled to realize how high the numbers actually were. While some may not be in a wheelchair full time, it still brings light to the situation at hand that we need to help these people out as much as possible. That requires that we take a step back and analyze what it would be like if we were in their shoes which is what our group tried to do for this project. When looking at the earth as a whole and analyzing the percentage of people who need a wheelchair, the number may seem small to some, but if you analyze just how many people that actually is, it can be quite surprising. The Wheelchair Foundation released information on this topic, and this was a fact that stood out to us, “Overall, of the 7,091,500,000 people in the world, approximately 131,800,000 or 1.85% require a wheelchair” (“Wheelchair Needs in the World”, 2017).

It’s crazy to think that that many people need a wheelchair. It’s also scary to think that some of these people aren’t able to afford all of the products that can make their lives easier. That is one thing that we are striving for in this project is making sure that the device is cost efficient so that everyone can have access to it.

In closing, we hope that this information provided a little more insight and knowledge on why we are doing what we are doing. Our determination to help these people is our motivation is completing the task to the best of our ability. As you go through the rest of this paper, we hope that you will put yourself into the shoes of a person in a wheelchair and examine the product from their point of view.

ENGINEERING DESIGN

Our general idea for this project is based off an issue of someone that we personally know. Computer Systems Engineering Professor Benjamin Manning, from the University of Georgia, expressed some grief when it came to be exiting his car in the rain. He explained that it took quite some time to get his wheelchair out of the car. While we could not optimize the wheelchair or even the car, we decided to focus on a smaller centralized issue as we believe that even

solving a few people's problems is worth the work of the task. One of our group members' grandmother is also in a wheelchair, and she always has to hold an umbrella when exiting her car. This becomes an issue because she needs her hands free whenever she is trying to get her wheelchair or carry her things. While some may argue that this issue is not worth examining, it can be seen that solving some of the simple issues can make the biggest difference.

The idea of building a retractable roof umbrella came to us after discussing this issue. It would help all sorts of people including and not limited to older adults, people with disabilities, and even impractical uses such as using it for shade at outdoor events.

Our idea mainly focuses on the car, the rain, and the person within the car. These three things make up the variables of our issue. In thinking about these things, ideas are already generated, but all three variables need to be included for the idea to be considered valid. One idea that we evaluated was the idea of a wheelchair umbrella. This umbrella would attach to the wheelchair to prevent the person in the wheelchair from getting wet while going towards the door of where they would be entering. However, once they get in their wheelchair, they would already be wet from getting it out of the car. That means that we should solve the problem before that issue. That moved our ideas back a step which led to discussion about how we would keep water from getting to the person with disabilities without taking up their hands in the process. That is when the idea for a retractable umbrella came about. This umbrella would attach to the roof of the car and could be extended and retracted with the click of a button. This issue seems complicated to solve, but the general concept of it seemed very easy with just a few obstacles to overcome in our own abilities and skills. The items needed to make the retractable umbrella would need to be cost efficient so that people with disabilities could afford the product for their own personal cars as well as need to be easily installed so that any car shop could install it in a breeze. The concept would also need to be universally able to install on any car as to provide rain protection to anyone who may need it.

THE DESIGN PROCESS

The design process we have is a simple five-step process. We are defining the problem by explaining how people with disabilities are affected in any way. We would have a list of customer or product requirements and information about the product features and functions. We are gathering information by surveys, data, and research and using that data to construct the

information. We are generating solutions by explaining how this project will help the people with disabilities. We will consider the best solution to use by considering cost, safety, and other criteria. Within detail, the analysis we gather will determine our final solution for us to test later on. During testing, we will have a prototype and a concept to test and implement the solution.

1. DEFINE THE PROBLEM

The problem simply stems from the fact that most people don't analyze the simple inconveniences that happen to a lot of people. However, our belief is that if the small inconveniences happen often in your life, then they tend to become a reoccurring hassle that seem to never end. It is our mission to handle this small issue so that we can make people's lives better one problem at a time. This particular problem pertains to the rain. While the rain is something that cannot be helped, humans have found ways around solving this issue for centuries.

Whenever we wanted to stay away from the elements in previous centuries, we built buildings and shelters to cover ourselves. While it was merely for our own convenience, it turns out that the rain can lead to pneumonia or people getting sick. When it came to be walking from place to place, humans invented the umbrella so that we could have a portable shelter to shelter our bodies from the rain. While the problem has been solved for most humans, there becomes an issue when it comes to disabled people, specifically those in wheelchairs. While many people don't realize it, a lot of people in wheelchairs drive themselves. If it happens to be raining, they are forced to get their chair outside their car while the car door is open. During this several minute process, their chair seat is getting wet, their clothes are getting wet, and water is getting inside of their car. By the time they sit down, their clothes are soaked, and they risk getting sick. A lot of times, some people in wheelchairs often struggle from other illnesses and additional sickness can lead to more serious health issues.

That is why we saw a need to face this problem. The problem that we need to fix is figuring out a way to have a hands-free shelter for people in wheelchairs to be able to use so that they can enter and exit without getting completely drenched. From the point that they get in the wheelchair, they would then be able to use a regular umbrella to transfer from the car to inside. That leaves us solving the problem from when they stop the car to when they get into their wheelchair. While

it is a short time frame in terms of things, it could make a world of difference as it would prevent someone from having to sit drenched in a wheelchair for the rest of their day and possibly take the risk of getting sick.

As known in the engineering world, there has to be a recognition for a problem before a solution can be made. Besides the random finding of fire, most issues need to have thought brought to them before an adequate solution can be produced. While we may claim the solution to this problem, we recognized the need when our engineering professor expressed some of his common griefs as a man who lives his life contained to a wheelchair.

Solving this problem may help him out one day and it may could help other people that we had not taken into consideration. In looking that this situation, we imagined ourselves in his situation and evaluated the way we felt. At the school we attend, it's been raining non-stop for a week and we thought about how uncomfortable in our wet clothes. While it is easy for us to change our clothes or fix the issue, it wouldn't be as easy for a person in the wheelchair. Even though we cannot actually put ourselves in Dr. Manning's shoes, we recognize the struggles that he faces.

2. GATHER PERTINENT INFORMATION

In analyzing the issue, the design process requires that we find pertinent information to later help assess our invention. This helps us come to the best possible solution without inventing something that has already been made as well as helping us realize if our invention would really help someone or if it's just a silly idea. In looking at our problem at hand, we realized that just hearing the problem from our professor would not be cause for a need for a solution. While it is great to help just one person, designing and building a project requires a lot of time and energy and we don't want to waste our time on a product that wouldn't be able to be used by many.

After some online researching, while we didn't find any scholarly websites with articles, we did find feeds of people who are contained to a wheelchair expressing grief about the issue. This tells us two different things. The first point is that it seems that this problem has never been addressed or brought to anyone's attention. This means that we would be the first ones to have a product on the market which means we would not only help people, but also have a chance in a competitive business market. That is important as you have to keep the business open for people to benefit.

The basic “umbrella” was invented more than over 4,000 years ago and it served for one major purpose. There is evidence of the invention of umbrellas which dates back to the artifacts of Egypt, Greece, and China. So, what did these people use this umbrella for? As I mentioned earlier, the umbrella had one main purpose in which they were designed to provide shade from the sun. Additionally, the Chinese were the first to waterproof their umbrellas for the use as rain protection and the rest is history. Since then, the umbrella has only been optimized in the smallest ways. That is what is wrong with a lot of problems today. As humans, we thrive to solve issues in our lives, but we tend to only go to the extent to where the issue is solved rather than making it better and better over time.

In answering whether or not the solution has been solved or if other existing solutions exist, we are able to see that while there are other inventions that address this problem indirectly, there is nothing that has been invented to handle the time frame that we are referencing. In looking through the feed online, we found that a lot of the products that address this issue would not be suitable for someone confined to a wheelchair. While the person in a wheelchair could wear a poncho, it wouldn’t be easy for them to change in and out of it, but also, the seat of their wheelchair would already be wet before they were even able to get into the seat.

Umbrellas are an amazing invention are very useful. However, when comes to transferring to a wheelchair, both hands are needed in order to make sure that the transition is safe and that no accidents occur. So, that means that umbrella would only be useful after they got in the chair and were able to use their hands. Even then, it takes two hands to roll a wheelchair which still leaves them getting wet.

When looking for companies manufacturing solutions. We found several companies which were manufacturing wheelchair umbrellas. These work by having an attachment on the end of the handle of a normal umbrella in order to clamp onto the wheelchair to keep the rider’s hands free. That means that that idea no longer needs to be addressed. That only leaves the time frame we were originally trying to tackle which is the transition from car to wheelchair.

In searching for alternate solutions, our search led us nowhere except to threads of people talking about the issue. One particular solution they had to the wet seat solution was expressed through this man’s statement, “As I have to assemble mine, I invested in waterproof trousers (not cool

but beats a wet bum) from outdoor/camping shop" ("Wheelchair + Rain = Wet", 2015). While this is a great solution, it is definitely not ideal to have to wear waterproof pants every time it starts to rain. This solution would also not be helpful against random rain storms. While the weather is predicted most of the time, rain can show up in no time and ruin someone's day.

3. GENERATE MULTIPLE SOLUTIONS

The next step in the design process is to have multiple solutions to this one problem. Rain would be our main focus, but we also have shade for convenience. Let say the driver is the one who is disabled. The driver can just hit one button from the remote, and the machine would do all the work. With that being said there are other solutions that could not possibly work because of the inconvenience.

Having an umbrella attached to a wheelchair is a possible solution, but it would take too much time, it wouldn't get the job done. The disabled would have to take the wheelchair out of the vehicle. Then, they would have to attach the umbrella to the wheelchair. Finally, by the time comes, they would already be soaked.

Having a raincoat wouldn't be efficient either. Some of the disabled would have to wear the raincoat all day because they probably can't be able to take it off. Even if they do wear the raincoat, then the wheelchair would be soaked, and if they put back in the car then, it would make the inside of the car wet.

We believe our product would satisfy all the needs. We put ourselves in their shoes and saw what it would be like going through this situation. Our product would be easy to set up. It would also be easy to use by one click of a button. First, the material we will use for the umbrella would be waterproof and not water resistant. In theory, any fabric between you and falling rain will keep some water from reaching your skin, making it at least partially water resistant. Assuming the umbrella's outer surface isn't some absorbent material like cotton, it likely could handle a light drizzle. If you're out for an extended time in the rain, or the intensity of that rain increases, though, you're going to get wet. If you want an umbrella that can stand up to serious rainfall, then the technology game also gets serious. To achieve a truly waterproof fabric, umbrella brands experiment with a seemingly infinite variety of outward-facing fabrics, as well as high-

tech laminates or coatings in layered constructions. From a lab-results perspective, a fabric is considered waterproof when it reaches a certain level of water resistance. But there's no agreed-upon industry standard for this value, so you have to trust a brand's claim that a fabric is waterproof. If you trust the brand, you can probably trust the designation, but you won't be able to easily compare levels of "waterproofness" between brands.

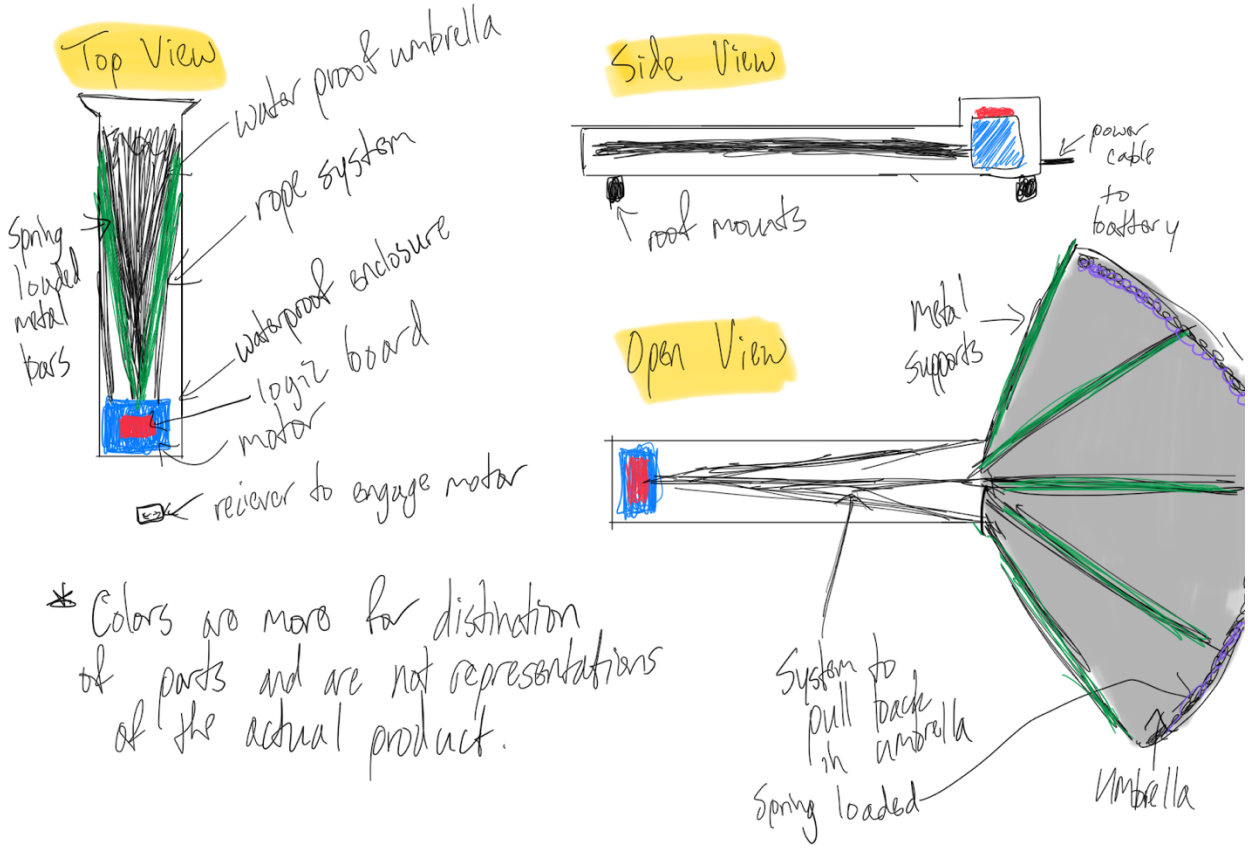
If the only goal is keeping rain out, then one could simply fashion a plastic bag into a jacket. The minute you exert yourself, though, your own sweat will make the umbrella feel like a sauna. Inexpensive umbrellas can shed rain and meet waterproof standards, but you only want to use one if you're planning to sit or stand still.

In the end, it's the combination of waterproof and breathable technologies that will keep you the driest if you're headed outdoors during a serious rainstorm. Today, you can find dozens of umbrellas with similar technologies. It's worth noting that in general, the drier you want to be, the more you'll need to spend.

Brands test breathability in the lab, too, again using a variety of methods and mandated results. The takeaway is the same, though: Comparing performance between brands isn't possible, but, if you trust a brand, then you can trust its waterproof umbrella has been rigorously tested.

Water repellent coatings are used on both water-resistant and waterproof jackets. The easiest way to explain what this coating does is to look at the surface of a new rain jacket during a light rain. When you see water drops bead up and roll off, you're seeing water repellency in action. A water repellant coating doesn't turn a water-resistant umbrella into a waterproof one, but it does increase the level of water resistance of any umbrella. It also prevents the surface layer of a waterproof umbrella from getting saturated, enabling that umbrella to operate at peak efficiency.

4. ANALYZE AND SELECT A SOLUTION



While nobody in our group is an artist, we used an iPad Pro in order to sketch out our design in order to better illustrate our thought process on our invention. Given that, we decided it would be best to provide different viewpoints and orientations to capture the movement and behavior of the device.

Beginning with the “Top View,” we see the different components that are labelled which make up the Handibrella. As seen in blue, we have the motor which is run off of the car battery. This allows the umbrella to be extended and retracted with ease. Moving forward, the red square represents the logic board. This is the brains of the product and will be used to trigger the motor whenever the button is hit on the receiver and we may consider adding Bluetooth connectivity in order to allow the device to be engaged from outside of the car. The top view also shows the umbrella in a folded-up position as well as shows the support rods which support the tension that is produced on the umbrella. While not able to be fully seen, all of the technology is covered by a slim waterproof box.

Speaking of slim design, that is what we tried to capture in the side view. Given that it is an umbrella, the box just has to be as tall as the motor. This means that when mounted to the top of a car, it should have a very slim design as not to take away from the aerodynamics of the car. Two additional parts are represented in this view which are the power cord which is attached directly to the battery as well as the car mounts. The entire concept is based sort of off the design of an LED light bar that goes on a car in terms of power and attachment.

The open view picture is what captures the true purpose of the device. The umbrella works by automatically wanting to come open as soon as it exits the tube. The idea is that the umbrella is spring loaded, and the springs will compress as the umbrella is pulled back in. The remote would allow for quick and easy access to this and would save the person from getting wet. That is where the software aspect of the project comes into play. Overall, while this build seems simple, it will take some logic and problem solving to bring it all together.

Some criteria that we are basing our idea off of is cost efficiency, product size, usability, helpfulness, and overall design.

Cost Efficiency: 20 points
Product Size: 10 points
Helpfulness: 20 points
Usability: 30 points
Overall Design: 20 points

5. TEST AND IMPLEMENT THE SOLUTION

The final phase of the design process is implementation, which refers to the testing, construction, and manufacturing of the solution to the design problem. While we haven't fully tested the product, we have set some guidelines that we are striving to follow in order to test our product to its full capability. In order to do this, we must first figure out some mechanical issues in order to implement the device in a manner that will work.

Some key issues that we must overcome is figuring out the spring mechanism as well as figuring out a way to get the umbrella to extend and retract through the use of the motor. It is very important that in the design process we use a spring on the umbrella that will be able to withstand the weight of the actual umbrella Along with this, we have to find a way to waterproof

everything meaning, finding materials that will be able to obstruct the force of heavy rain. By doing this we are able to understand the use of this designed umbrella which is to block heavy rain for the handicapped people coming out the side of a car.

When making the prototype, we will know that it won't work at first because prototypes are mainly for design solution. We will test the prototype during a rainy day to see if it can withhold the problems it can face. Only after testing under all expected and unusual operating conditions are the prototypes brought into full production.

But before we make the prototype, we would have to make a 3-D model. Luckily, one of our group members know how to use a modeling software called AutoCAD. With the appropriate software, the preliminary design can also be analyzed for functionality as the design is being created. Using the results of this analysis, we then make any necessary modifications and reanalyzes the computer model.

As known in not every but most engineering projects, there is test and experiment process. For this particular project there were things to consider before testing the design which were: finding the weight of the umbrella, looking for which springs to use, building the box, and finding out the amount for all the products we are using.

Documentation would also be very important. During our build week, we would have to make checkpoints and notes of where our progress is. We will communicate a lot during the process so everyone in our group can be on the same page and fully understand what we are working on. We will also use graphs, charts, and other visual materials to summarize the solution process and present your work to others. PowerPoint presentations, slides, sounds, videos, and computer-generated animations are will be used to clearly communicate the solution to a design problem.

Testing and verification are important parts of the design process. At all steps in the process, we may find that our potential solution is flawed and have to back up to a previous step to get a workable solution. Without proper testing at all stages in the process, we may find ourselves making costly mistakes later.

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