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0.0 Summary

Our engineering firm known as JAAAY is composed of five unique and well-rounded individuals that are capable of producing the most reliable technology needed in the modern day. For this project, we chose the task of improving the lifestyle of citizens that face hardships while opening their smart household door lock.

Our client deals with numerous health issues that affect her capability in entering and exiting her household. Kim suffers from multiple sclerosis (MS), an incurable disease that affects one in every 385 Canadians [1]. MS constantly decreases our client's dexterity and lead her to use a wheelchair as her method of transportation. While spending most of her day in her wheelchair, one of the greatest hardships she faces is entering and exiting her household. More specifically, while entering her household Kim is required to position her wheelchair in an uncomfortable angle relative to the door, use a pencil to enter a four-digit door pin and push down on the door handle using her palm. Taking into consideration the client's problems and health issues, we developed a device called "The Handy Hook" that exceeds the client's needs as shown in Figure 5 Appendix B.

In order to benefit the client, we ensured that the device includes specific traits. In the production of The Handy Hook, only materials that are lightweight were used in production to result in a product that is less than three pounds. Overall, the main benefit of our device is to decreases the time period for the client to enter and exit their household. Furthermore, the device provides an easier method for the user to: enter their four-digit door pin code and an easier method to push down on a door handle and push the door open. We also included: numerous grips on the device to ease the experience of holding and utilizing the device, hand support for the user to easily control the device and, lastly, a wrist strap for the device to be easily retrieved if dropped.

Understanding the daily hardships of our client, our firm designed a reasonable and remarkable design that will change the lives of many around the world.

1.0 Introduction

1.1 Background Information

Our client, Kim, is an elderly citizen that deals with hardships while entering and exiting her household. Kim is diagnosed with an incurable disease known as multiple sclerosis. MS still plays a huge factor in Kim's life by continuously decreasing her dexterity and restricting her to utilize a power wheelchair as her daily method of transportation. Currently, Kim enters her household by following multiple uncomfortable steps. In order for her method to work, she first needs to carefully hold onto a pencil. Then, she approaches her apartment door, parking her wheelchair at an awkward angle relative to the door and uncomfortably uses the pencil to try and plug in her four-digit door pin. Shortly after entering the code, in a limited amount of time, she is required to push down on the door handle and finally push the door open. Moreover, the client has described that if the pencil used in this process is mistakenly dropped from her fingers it is impossible to retrieve it and will need the aid of her neighbor to enter her household. Furthermore, another problem Kim faces is that if she does not push down the door handle in the limited time described, she is forced to repeat the entire process again.

This project is severely based on improving our clients lifestyle. As an engineering firm, we brainstormed, planned out, discussed, designed and overall developed a product that would help our client Kim to easily enter and exit her household door. The device we constructed servers several benefits for our client that decreases the time required to enter and exit her household. Our device provides an easier method of entering a four-digit door lock pin, pushing down on a door handle and pushing a door open. One benefit is that she does not need to position her wheelchair in an awkward position after entering the door lock pin. In addition, since our device includes numerous grips it enhances the user's experience in holding and utilizing the device. The Handy Hook also includes a hand support to increase the user's control over the device. Lastly, another benefit

our client will enjoy is the additional wrist strap at the end of the device. This will result in the device to be easily retractable if it is dropped.

1.2 Refined Problem Statement

Design a portable solution that helps people in wheelchairs with limited strength, such as Kim, to easily enter their pin code, push down the door handle and open their house door.

1.3 Objectives, Constraints and Metrics

While going through the design phase, it was very important to have objectives and constraints upon which we based decisions to achieve the best final product. Objectives are what a design should have, whereas constraints set a limit on the design. To add, metrics are used to determine the design that incorporates the most objectives. Metrics were established for each objective and points were awarded (100 points being the best and 0 points being the worst) based on how it fits the criteria, as seen in Table 4 Appendix B. The design with the highest total points was the design that we decided to continue with.

The objectives as seen under the objective tree (Figure 1 Appendix B) include low cost, ease of use, durability, and portability. Firstly, we built our final product with cheap, yet durable materials as we wanted our final product to be inexpensive. If part of the product were to ever break, it would be easily affordable to replace. For our metrics, we decided that a design under $49.99 dollars was reasonable and, therefore, awarded 100 points. Furthermore, another objective was ease of use. Since Kim has low motor skills we needed to create a product that would be simple enough to use in order to overcome this barrier. For the metrics, if the design took 60 seconds or less to use, it was sufficient enough and awarded 100 points. Additionally, we want our device to last as long as possible and, for that to be possible, the objective durability must be considered. The device must be durable enough to withstand potential forces (either dropping or banging) it faces. For this

objective, we established that if the device can last 10+ years, it would be rewarded 100 points. Though we were not able to accurately test for this metric, we made educated predictions based off of the design. Moreover, our final objective was portability. Since the device is used for Kim to enter her front door, she will need to be able to carry around the device without it getting in her way. For portability, our metrics were that it would score 100 points if the design weighed less than two pounds as we want the device to be as light as possible (All other grading divisions for the metrics can be found in Table 1 Appendix B).

The constraints used include fitting in the wheelchair, weighing less than three pounds and withstanding a drop of three meters. The device had to be smaller than her wheelchair to ensure that she carries around the device. In addition, the design needed to weigh less than three pounds as Kim has minimal strength and it would be difficult for her to lift it if it were any heavier. In addition, the device needed to be able to withstand a drop of one meter as that is the approximate height at which the device will be held. These constraints had to be met when we were in the designing stage of our project.

1.4 Prior Art

1.4.1 Existing Products

Our firm is designing a product that helps our client to enter and exit her household door. Being in the modern era of technology, numerous commercial products exist with very similar tasks. After conducting research, we have found that most modern products include a remote controlled or an electrically powered system that automatically opens the door with no need for human interaction. One of the products found was the August Smart Lock Pro 3rd Generation $300 Canadian dollars [5]. The August Smart Lock can be easily set up and requires a smartphone to function. The utilization of this product would easily make our clients life simpler as it would only require her to press one button on her smartphone to obtain the goal of unlocking her door.

Therefore, through simply installing the August Smart Lock and downloading the August Smart application on a smartphone, unlocking and locking the house door would be simpler than ever. After the door automatically unlocks, the user is only required to push the door open to enter their household. In addition, if the user incapable of pressing a button on their smartphone to unlock the door, the August Smart system also comes with a built-in Bluetooth system such that the house door automatically unlocks when the device with the downloaded application increasingly gets closer to the household door. This device is the best on the market to obtain the goal of entering and exiting your household without facing any issues.

1.4.2 Patents

Before we started incorporating ideas into our design, our firm took the time to discover existing patents that focus on solving the problem of easily unlocking and entering a household door. The patents we found were used as inspiration to begin thinking about how our design can function. One of the most useful patents was the “Easy door opener” developed by Philip M Hohl in 1971 [4] refer to Appendix D Patents. We came to the conclusion that this design would have been the most convenient for Kim because no adjustments would be needed to be made to her actual door. The basic design of this patent is the grip would attach to her lever style doorknob, by clamping onto it, and the handle would decrease the amount of force she needs to exert to get the door open. One of the ideas we implemented from this patent was the curved door handle grip, as this would make it convenient for her to grip onto the door in an easy way. Then, we added on several other features to make our device unique like an ergonomic handle and a hand resting plate at the bottom of the device.

2.0 Conceptual Design

2.1 Brainstorming

In tutorial five our group was given the opportunity to use the 6-3-5 method to get as many ideas as possible from each group member. All group members contributed different ideas for potential issues our group

was going to tackle. Each person would draw an idea of how they think we should approach a certain problem and would pass their drawings around and each group member would add on to those drawings making them better. When we started, most of our team drew their first drawings based on Kim's problem and we all had similar ideas on how to approach the problem. Due to this, we all kept adding on to the base idea we had which was adding a hook to the end of a stick. The ideas that we added on were adding an angle of the stick, the size and how the device would attach to her door handle. Our brainstorming session consisted of everyone in our group adding onto the same idea, it was very convenient because we all kept improving our design each round. Since we did not want to restrict ourselves to only Kim problems in our second round of the 6-3-5 method each individual was told to come up with a solution to a different problem other than Kim's door opening problem. We followed the same process as our first round of 6-3-5 by passing each persons sketch around and critiquing. For these problems, our group did not really know where to start, and the ideas we did have seemed too basic and obvious. We concluded by taking a group vote as to which solution was the best for approaching Kim's problem, and the vote turned out to be unanimous.

2.2 Process

During our early tutorials after we decided to tackle Kim problem, we came up with a couple of initial designs. Before we started designing, we tried to address the main concerns for Kim while she opens her door. These concerns were taken into account and we tried to implement clever solutions when designing. As seen in Appendix B, Figure 2 and 3. In Figure 2 we planned on using a long stick with a plumbing wrench end, this part would then attach to the door handle and tighten onto it so Kim can push down. Using a plumber wrench has its benefits like it has support when she is pushing the door open. As seen in Figure 2 when we push the door open the back part of the device will help open the door. It also had a pointer at the end of it which would be used to input numbers into her keypad. For our second design alternative shown in Figure 3 Appendix B, we planned on using the same type of stick extension and attached to that would be a box-like structure which would go around

Kim's door handle and attached to that would be 2 sticks coming from either side so that the device can be used in any orientation. The benefits of using the box design would be that the device won't slip off the handle because it will go around it. Both the designs would use the same type of method to extend Kims reach but they both had different ways of opening the door handle.

2.3 Outcome

In our final design, we made many alterations from the previous prototypes. Between the second prototype and the final design, we were left with lots of possibilities from the design review. At this point, the main feedback we received was to make the design lighter, to implement this we used thinner PVC pipe. By doing this we reduce the weight and improve the accuracy of the device when punching in the keypad. These are two key factors that a design for Kim would need, as she has limited strength in her arm and low dexterity in her hand. The second feedback was whether we should change the thickness of the handle. In the end, we decided to make it thinner because as Kim's condition gets progressively worse it will be harder for her to close her hand. An alternative to the current final design was to start with the hook on an angle so Kim would not have to turn her hand the full ninety degrees to a more difficult angle, however, this would make it less intuitive and harder to begin turning the door handle, thus we decided to not change the angle. Another design alternative was to add weight to the hook end, as a group we decided to stick to keeping the lightest design possible. We concluded that it wouldn't be as beneficial to her because for the weight to be effective it would have to be quite heavy, which she would struggle to hold.

As for the decision matrix, our final design fits with all decision matrices (Table 4 Appendix B). As for the constraints, our design is easily under three pounds and is very small so it is able to fit in the wheelchair. The design meets our first objective of low cost as it only costs $13.45 to make. The second objective we had is ease of use. To test this we went to Thode library and asked other students to open a door without giving them any instructions and they were able to. Thus proving it's a simple yet effective design. The third objective we

had was durability, we tested this by doing multiple drop tests and stepping on it. After thorough testing, we did not see any damage to the device. The last objective we had was portability, considering how compact the design is, it can be put in a bag or can be hung with the wrist strap. Therefore the design is portable and meets all the design constraints and objectives we had set for it to be an effective device for Kim.

3.0 Final Design

3.1 Description

The Handy Hook is a state of the art device that allows our client to easily unlock and open her household door. The device was designed to have three specific primary functions including: entering a four-digit door pin code, turning a door handle and pushing a door. Even though The Handy Hook was initially designed for individuals with MS, the device is also capable of being utilized by individuals that are in wheelchairs. In addition, the materials used to compose the product have been carefully chosen, to result in a product that is lightweight, low cost, durable, and portable. Figure 2 Appendix A displays a picture of a simplified version of our device.

3.2 User

We designed this device to be easy to use and intuitive, it only consists of five easy steps which anyone can do. From looking at our device, it is obvious on how to use it because of the simplicity of our design.

The proper way to use the device is as follows, first the user is supposed to put their hand into the wrist strap as seen in Figure 1 Appendix A. Next they will need to grab onto the handle of the device and rest their arm on the wrist rest as illustrated in Figure 1.1 Appendix A. The user will then input the code into the keypad by using the pointer located at the top of the design, also seen in Figure 1.2 Appendix A. Lastly after the code is inputted into the keypad, the user is then going to latch onto the door handle using the door hook located at the front of the device. From there they will pull down on the handle then push the door open this is also illustrated in

Figure 1.3 Appendix A.

After the user is done using the device it should be stored properly to ensure that it is not damaged. To properly store The Handy Hook the user should place it in a holster, storage tray or hang the device off the side of the wheelchair. It should be noted that hanging the device off the side of a wheelchair can be potentially dangerous and must be done in a way that ensures that the device does not sway back and forth when moving. The recommended place to store our device would be the highlighted area in Figure 1 Appendix D. The door hook part of The Handy Hook can slot into that gap in her chair and it would stay sturdy in place while she moves around, in addition, it is in a place easy for the user to reach.

3.3 Construction

The Handy Hook was constructed by utilizing: two pieces of PVC tee connectors, two pieces of thin poly nipples, a rope, a wooden dowel, and plywood. The two pieces of poly nipples were connected using a PVC tee connector to create a 90-degree object. We decided that a 90-degree design would be the most suitable for the client after testing numerous combinations of the two poly nipples. One of the poly nipples was identified as the handle and was cut down to 5 inches to result in a more optimal length for the user to hold. Meanwhile, the second poly nipple was used as an extender of the device, to ensure that the user does not need to lean forward while utilizing the device. The second circular PVC tee connector was then cut in half to the same size as the client's door handle using a jigsaw to create a hook-shaped object. The hook was then glued to the end of the extender using a hot glue gun. A wooden dowel was then cut into three inches and hot glued from the PVC connector to the top of the hook to act as the pointer of the device. In addition, using a laser cutter, a piece of plywood was cut into a circular shape with a smaller inner circle cut to fit into the handle of the device. The handle of the device was then placed through the inner circle of the disk to act as a hand rest. At the bottom of the disk, we added a PVC cap to get rid of any sharp edges found at the bottom of the device. A rope was then added at the bottom of the device to create a wrist strap to make the device easily retractable if dropped. In

addition, shelf liner was utilized as grip and was placed around the handle and the wooden disk to provide comfort for the user when using our device. Shelf liner was also placed inside the hook such that the hook does not slip once it is placed around the door handle. Lastly, hot glue was added at the end of the wooden dowel and the sides to the hook to ensure that the device does not damage the door.

3.4 Safety

It is important to take safety into consideration while utilizing this product. The product is capable of resulting in injury and harm to a human body if it is misused. Since the device is placed on the wheelchair, it is important to ensure that the pointer of the device is pointed away from the users and away from any bystanders when it is being stored. For example, if the pointer is not placed facing the ground, it may result in poking a child's eye. The position of where the device is placed should be carefully chosen. In addition, placement should be taken into consideration since if the device falls under the wheelchair it may result in damage to the wheelchair and more importantly the user of the wheelchair. If the user stores the device as mentioned in section 3.2 it will ensure that not only the device will be protected but the user and others around the user.

3.5 Final Design Decision Explanation

Before building our final product, we validated our design by referring back to our original matrix table (Table 4 Appendix B) and assuring all the objectives and constraints were met. Our final design closely resembles our second prototype (Figure 6 Appendix B). However, it includes a few modifications and improvements, which were addressed in the second design review. The overall device was lighter than the previous prototypes, so it will be more suitable for Kim. In addition, the final device was also made smaller than the second prototype to reduce the amount of force required to pull down the door handle. Furthermore, the design is more durable and will be able to withstand more force since it is made out of stronger materials. We also put more details on the final design such as adding grip onto the hook to increase the grip on the handle.

Overall, the final device keeps the advantages as the second prototype and solves most of the weakness according to the feedback of design reviews.

3.6 Discussion of Feedback from Design Reviews

The design reviews played a huge role in obtaining the final design of our product. Being able to receive feedback from science students allowed us to enhance our products in aspects we forgot to initially take into consideration. Our first prototype displayed in Figure 5 Appendix B initially had the pointer in the middle of the hook. It was brought to our attention during the design review that the user would be incapable of seeing the pointer while utilizing the device if it remained in the middle of the hook. This would make it hard for the user to effectively plug in the correct pin code. Therefore, through this feedback, we decided it would be best and most effective for the user if the pointer was placed at the top of the hook. In addition, our engineering classmates provided us with the feedback that it would be better if the wrist strap for the user was made wider. This would allow the user to comfortably place their around through the hand without facing any form of hardship. For the second design review, it was suggested that we should use thinner PVC pipe as the handle of our design to allow the client to easily hold the product. Therefore, for our final design, we replaced the PVC pipe with thin poly nipples to create the handle of our device. In addition, we added shelf liner around the handle of the device to act as a grip. The grip increases the comfort of the user when holding the device and makes the device hard to drop while it is in use. Lastly, grip was placed inside the hook to prevent the device to slip from the door handle.

4.0 Conclusions

After following the design process, by researching, designing, critiquing, and redesigning the final product that our group came up with meets and exceeds the needs of the user. Overall, throughout our multiple iterations, each prototype was improved upon which led us to the final design. The final design takes into

account all the feedback we received making it the best product for our users to interact with. Referring back to the metrics that we established back in our early tutorials we can now compare how well our device did based on those criteria. Referring to Table 1 Appendix B, we rated all our metrics on a scale from 0-100, with 100 being the best. The maximum amount of points that we can score is 400.

The first metric was cost and the overall cost of our final device was $13.45 (Table 1 Appendix A). This is a very cheap cost of manufacturing, allowing a large population of individuals to buy it. Since our cost is below $49.99 that means we would get 100 points for this section. Cost is an important factor when producing a device since if part of the device ever breaks, the user would not want to spend a fortune to replace that part. Not only should our product fit the functions and constraints of the users, but the users should be able to afford the device so that they can actually use it.

The second metric was durability, this metric is measured by the number of years the product will last. Since we cannot test this metric using this method right now, we have used other testing methods such as the drop tests. We did many drop tests from various heights to make sure that no matter what realistic height the device is dropped from, it will be able to withstand the force. If we compare the drop test durability to the previous prototype, we would give our device 100 points because after all the drop tests it managed to successfully pass and still be completely functional.

The third metric was lightweight and it is measured by the weight of the device. The final weight of our device was 1.5 lbs, which falls in the category of fewer than 2 lbs which earns us 100 points for that section. It was very important that we made the device as light as possible as it makes it easier for the user to hold up and use the device.

The last metric was ease of use. The way our group tested this was the amount of time it took for the user to operate our device. We gave The Handy Hook to random people at McMaster University with the set of instructions and measured the amount of time it took them to understand how to use the device. From our

findings, it took on average about 30 seconds for individuals to figure out how to use the device. This gives us a score of 100 points because it falls below the 60 seconds mark from our preset metrics.

After reviewing our final design with all the metrics we made earlier in the year it is safe to say that our device meets the expectations we set. The Handy Hook ended up with 400/400 points which means it complies with the metrics we set back in our earlier tutorials. If we were to change our device and make it more usable, we would add a rotating extender. Rather than having a fixed extender, adding a rotating extender would allow the user to keep their hand straight as they pull down on the door handle. Even though we did not include this in our final design, it does not significantly change the output and benefits of our design.

After going through the whole design process we feel like this device is the best for Kim given our time constraint, because it meets and exceeds all her objectives and constraints. Our group went through many iterations to obtain our final design, and in each iteration, we made more and more improvements to make Kim's experience better than her current solution. Our final product is not only cost effective, durable, portable, but it is also very easy to use. The Handy Hook will have a positive impact on users who are in wheelchairs, with limited strength and are currently facing difficulties opening their house door.

5.0 References

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[5] “Smart Lock Connect,” *August*. [Online]. Available: https://august.com/products/august-smart-lock-3rd-generation. [Accessed: 02-Dec-2018].

Appendix A - Device User Guide

Figure 1 **Figure 1.1** **Figure 1.2** **Figure 1.3**

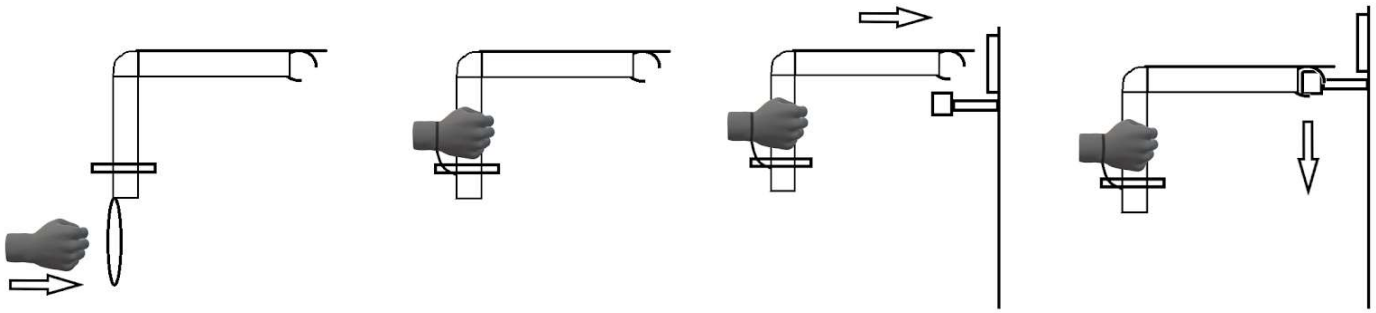

Figure 2- Detailed view of the device

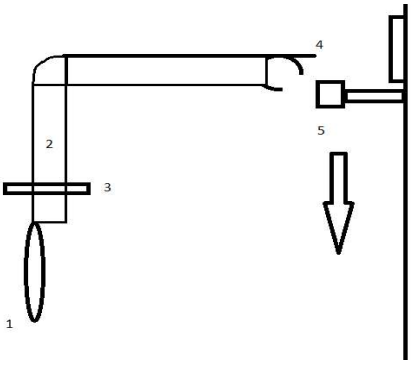

Table 1: Price Breakdown

Materials	Cost
4” PVC Tee Connector	$0.90
12” Wooden Dowel	$1.50
2x (0.5”x6” Cut Off Poly Nipple)	2x($1.50)
90 deg PVC Elbow Connector	$0.80
1”x 4” x 12” Wood	$1.75
PVC End Cap	$1.50
Shelf Liner	$3.00
String	$1.00
Total Cost	**$13.45**

Appendix B - Tutorial Workbook Information

Initial Problem Statement

Design a product that helps open doors for people with disabilities.

Design a product that helps people with limited strength such as Kim to easily get in and out of doorways.

Figure 1 :Objective Tree and Metrics

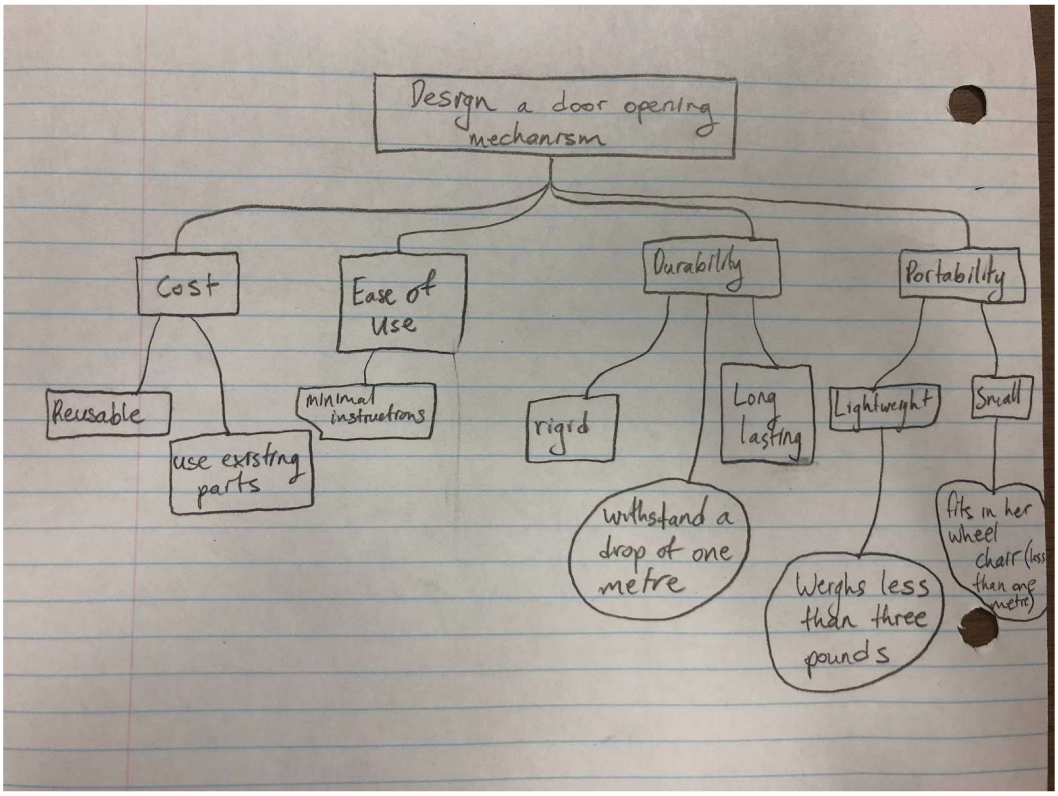

Table 1: Metrics

Objective	Cost
Metric:	$49.99 or less= 100 points $50-69.99 = 80 points $70-79.99 = 60 points $80-99.99 = 30 points $100+ = 0 points

Objective	Durability (Drop Test)
Metric:	Lasts 10+ years: 100 Points Lasts 5-9 years: 50 Points Lasts 2-4 years: 25 Points Lasts 0-2 years: 0 Points

Objective	Portability (lightweight)
Metric	Weighs < 2.0 lbs: 100 Points Weighs 2.0 lbs-2.9 lbs: 50 Points Weighs 2.9+ lbs: 0 Points

Objective	Ease of use
Metric	Time to Operate 0-60 seconds: 100 Points Time to Operate 60-180 seconds: 50 Points Time to Operate 181+ seconds: 0 Points

Table 2: Objectives and Constraints

Objectives	Sub-objectives
Cost	Reusable
	Use existing parts
Ease of use	Minimal Instructions
	Instruction manual less than a page
Durability	Rigid
	Long lasting
	Withstand a drop of two meters
Portability	Lightweight
	Small (fits in her wheelchair, less than 1 meter)

Our first constraint for the device is that it must fit in Kim's wheelchair. We chose this constraint because if she cannot carry it, then it is not useful. Our second constraint for the device is that it must be under 3 lb. This constraint is necessary because Kim has limited strength. Our last constraint is that it must withstand a drop of 1

meter.

Redefined Problem Statement

Design a portable solution that helps people in wheelchairs with limited strength, such as Kim, to easily unlock and open their house door.

Table 3: Morph Chart

Functions	Means			
The device must be durable for everyday use	Thick / Hard plastic	Metal	Wood	
Pushing the door open	Using a push stick with a flat end	Spring	Pump	Lever
Turns the knob	A hook	A clamp	A magnet which sticks to the handle	
Type on the keypad	Pointy stick	Mechanical fingers	A prosthetic finger attached at the end of a stick	
Easy to carry	Retractable	Wristband	Handle	Velcro attachment to the chair

Design Alternatives

Figure 2: Preliminary Alternative

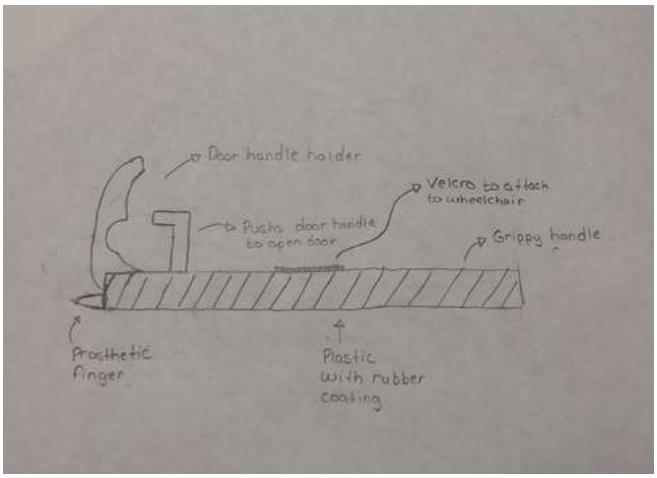

Figure 3 Second Design Alternative

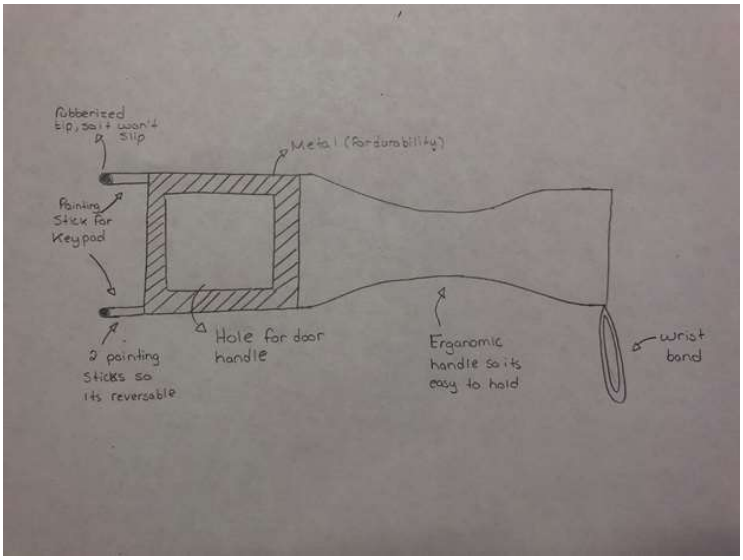

Figure 4: Secondary Alternatives

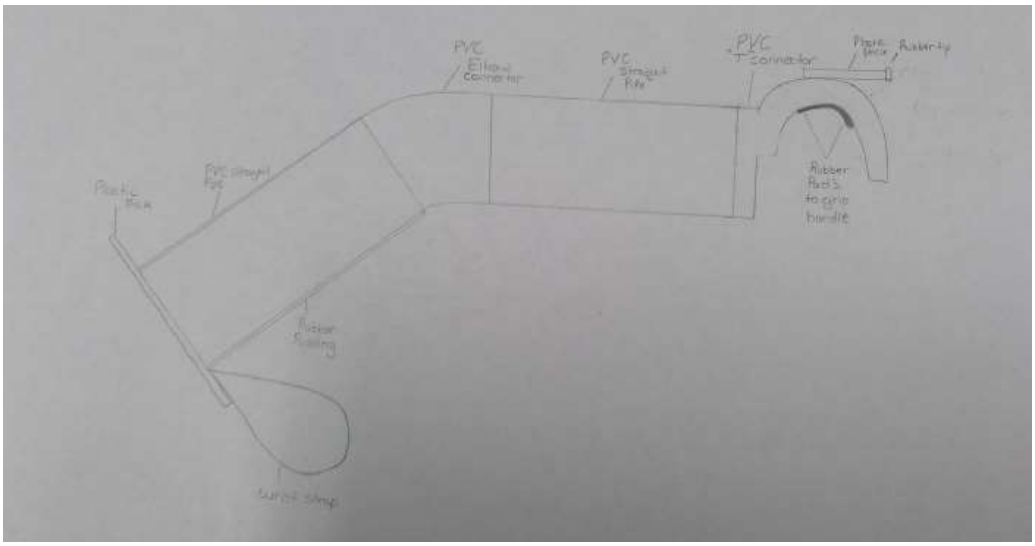

Table 4: Design Matrix and Evaluation

Design Constraints (C) and Objectives (O)	Priority	**Design 1** (has square hole with 2 pointers on the end)	**Design 2** (has a crowbar look with velcro pad)	**Design 3** (Long Stick with increases leverage for Kim)
Fits in Wheelchair (C)				*
Weighs less than 3lb (C)				
Low Cost (O)	✓	1 x ✓	0 x ✓	
Ease of Use (O)	✓✓✓✓	1 x ✓✓✓✓	1 x ✓✓✓✓	
Durable (O)	✓✓✓	1 x ✓✓✓	0 x ✓✓✓	
Portable (O)	✓✓	1 x ✓✓	1 x ✓✓	
Total Checks		10✓	6✓	

Figure 5: First Design Prototype

Figure 6: Second Design Prototype

Figure 7: Final Design

Appendix C - Design Review Feedbacks

Tutorial 7 Design Review Feedback

During the review feedback, we learned many ways in which we could make it better. One of the suggestions made by the science students was to make the hook smaller and use a clear plastic. By making the hook smaller it would be able to fit more tightly on the door handle. The other suggestion; using a clear plastic was back when we have the pointer in the middle of the hook, so having the hook clear would allow the user to see where they were aiming. Some points that the review team brought up were ways to make the device portable such as using velcro. However, as a team, we decided velcro can be uncomfortable and hard for Kim to use. Another point that was brought up was the ideal length for the bar and handle. As for this suggestion, we did not make any changes until our final design, as we were still searching for an answer. Another suggestion the science team gave us was to add grip to the hook. By doing this, the hook won't slip off the handle when using the device. To increase portability we were suggested to possibly add a folding mechanism, however, as we had already shortened the bar there was no need. One of the points they brought up was the ideal length for the bar and handle. This was discussed in the second design review and it wasn't until the final design in which we decided.

The peer reviewers made a few comments about our design. They suggested possibly using an angled PVC connector in between the handlebar and the extender. While this could have helped, we decided it would be best to keep the connector at ninety degrees due to the fact that, if we changed the angle it would reduce the effectiveness of the disk at the bottom of the handle. Like the science students, there were also concerns about the portability, which was fixed as previously mentioned.

Tutorial 9 Design Review Feedback

During our second science review feedback, we received less feedback as we had already made many modifications. However, there were still some flaws in our device. Firstly, one of the science students reminded us that as her condition worsens it will become increasingly more difficult for her to close her hand. With that in mind, we decided to use a thinner handle, such that even when her condition gets worse she'll still be able to use it. In addition to this, by changing thinning the handle it also fixes another problem that they had with our design, which is that it was too heavy. By using smaller sized plastic we were able to drastically reduce the weight. Another one of the suggestions was to shorten the length of the extender bar. For this at first we thought that it would be good to have it long because she wouldn't have to lean or reach forward. However, after thinking it over, we shortened the handle and the bar. This is because the longer the extender, the more force is required to turn the door handle and the less accurate you are with the pointer. As for shortening the handle, this allows the user to use the disk at an optimal length from the extender. Some of the interesting feedback in which we did not include was starting with the hook already angled and using a rope. For the first one, we decided to not use an angled hook because it would be unintuitive and put the user at an awkward starting position; where they need the most strength. As for the second feedback, this required us to completely redesign our device without being able to get any advice for the final product, so we chose not to go down this route.

The peer review team gave similar suggestions to the science students. They, like the science students, suggested reducing the weight and thinning the handle. The other suggestion they gave was to use a screwdriver handle as the grip. While this could have been good, we decided to go with shelf and drawer liner as it is comfortable and provides better good grip.

Appendix D - Extra Content

Commercial Products

Research Assignment #1

Most commercial products that open doors for people with disabilities are very similar. They will often be remote controlled and electrically powered, involving a motor connected to two other bars in a lever like a format. The motor is connected to the top of the door and the first bar is connected to the motor and the second bar. The second bar is connected to the door, thus when the motor is turned on the second bar will open the door. After the door opens, this product will also automatically close the door after a set amount of time. In the system, an electric door strike is included, which removes the need to turn the knob on the door for it to open or close. Considering the fact that this product only requires Kim to press her keypad and the remote to open the door, it will make her life much easier. Therefore, this product would be ideal for Kim, however, it is quite expensive costing anywhere above $300. The other unique product I found was the T-Pull. This design is similar to a door knocker, however, instead of the knocker it is a long T shape and is tilted 90 degrees. This allows the user to pull the door open or closed with an extended draw length. Using the T-Pull the user will not have to keep re-maneuvering themselves to reach the knob to open or close the door. The main thing I like about this device is that it is relatively cheap, it usually costs around $50 and can be set up easily. Even though this product only solves opening the door, and does not help with the turning of the knob, it can be combined with an electric door strike; thus making it preferable. Not only will Kim have an effective solution, but it will also be much cheaper than buying the automatic door opener system, considering the main problems for Kim are her fingers not being able to grasp well, and her lack of strength.

Patents

Research Assignment #1

The problem that our group decided to take on was to help Kim open her door. A variety of people have tried to solve this problem, and some already have active patents for the technology, which prohibits us from using it. Patents are legal documents which protect intellectual and physical ideas made by others, patents are usually created so others do not copy or take credit for someone else's work. Due to this reason, we cannot use these ideas listed below but learn from them instead. The first method would be a quite expensive method which is automating her door and using wireless technology for her to open it using a remote. This product was patented by Microchip technology Inc in 2001 called "System and method for remote opening of handicap access doors". This product works by Kim having a remote which she can use by clicking a button which would automatically transfer a signal to her door to open for her. This method would not only help her open the door but also it eliminates the need for her to unlock the door as well. Possible drawbacks to an idea like this would be that her building management may not approve of changing the door locks to her door and electronics need to be attached to the door for it to open. [2] The second idea which was patented by Thomas Industries Inc. in 1993 named "Easy opening door control device". It was a compression spring attached to the door which makes it very easy to open and requires little to no effort once unlocked. Some ideas we can take away from this is by adding something to the door which slowly opens the door using springs. This reduces the amount of force Kim needs to exert on the door. Right now, after Kim unlocks the door she pushes it open with her foot rest but if there is a spring mechanism attached to the door it will slowly open for her. Draws backs for this would be that it doesn't directly help her unlock and open her door, it just reduces the force needed to open it. [3]

The last patented idea would have been the most convenient for Kim because no adjustments would be needed to make to her actual door. This device acts as an extension to her arm which features a curved door handle grip and a long arm. The grip would attach to her lever style door knob and the long handle would decrease the

amount of force she needs to exert to get the door open. This product was patented by Philip M Hohl in 1971 called “Easy door opener”. [4] Though we cannot use these ideas because they are patented, we can learn from how they tried to solve this issue and implement small fractions of their idea into our design which improve our device.

Figure 1: Device Holder Location