Temporary Prosthetic (University of Toledo)

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The Design Team with Sister Pat Taube

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ABSTRACT

Amputation and the loss of limbs typically is the result of trauma or surgery (e.g. explosions, burns, cancer, peripheral arterial disease, diabetes, etc…). Usually people without limbs utilize a prosthetic device to help regain functionality of their missing member; however these do not result in the full return of all pre incident capabilities. A person's prosthesis should be designed and assembled according to the patient's functional needs. Due to the fact that prosthetics can take up to 18 months to be properly fitted, assistance and personal care is needed to help such a person throughout this time. The client Sister Pat Taube is a retired school teacher who as the result of an infection suffered in the summer of 2013 lost all of her limbs. The goal of this project was to provide a device to allow the client to use a telephone independently. The final design accomplished this by using two 3D printed prosthetics that she was able to take on and off independently with the use of cabinet latches, springs, and a guide rail. By placing her arm into the prosthetic interface and pushing back to release the

cabinet latch the springs would then clamp the prosthetic on to her arm. She then could pull the device off the guide rail granting her full range of motion. Once attached, the prosthetic interface was then able to accept a variety of different attachments that could be easily interchanged via the use of magnets. These mentioned attachments were a spork for eating, a stylus on her left side to dial and answer the phone, a pen to write, and a phone holder to hold the phone. At the completion of this project the client was able to make phone calls to her friends and family without the help of others, completing the original scope of the project. Also, in addition to this the prototype allowed her to regain back many more of the basic everyday functions which she had lost due to her condition.

http://www.youtube.com/watch?v=xPRcovRJ268

INTRODUCTION/BACKGROUND

The client, Sister Pat Taube is a retired school teacher who unfortunately lost all of her limbs due to an infection she suffered in the summer of 2013. With her disability she is fully dependent on others to take care of her while waiting for her prosthetics. As she was being fitted to have prosthetics manufactured for her arms she still wanted to be able to use the telephone to keep in touch with her friends and family.

The goal of this project was to create a device that would help Sister Pat use the telephone again independently without the help of others. As the project moved forward and after working with Sister Pat, it was found that she wanted a few more things. In addition to being able to pick up a phone and dial a friend, she wanted to be able to write down her thoughts, read, and eat. Thereafter, the goal of the project was to develop a device for her to independently complete a majority of her daily (Day to Day) tasks.

PROBLEM STATEMENT

Sister Pat Taube needs a device that will allow her to independently complete her daily basic tasks rather than relying on others to assist her. This device needs to be light weight, safe, easy to use, versatile, and cost effective.

DESIGN

The main focus of the design was firstly the independence factor, as the client lost most of this ability through her amputations. The prosthetic was then designed

around her preferences in regards to a variety of different attachments to help her independently perform daily tasks.

The prosthetic interfaces are attached to docking stations, which are held in place by a tab and a cabinet latch. These allow the interface to remain open when not in use. When in use the client could place her arm inside the prosthetic and apply a small force to release the latch, which would then clamp down on her arm through the use of two tension springs assembled within the interface unit. From there the client would then be able to lift the prosthetic off the tab giving her a full range of motion with the device. Depending on the task the client wishes to achieve, she could easily pick out an attachment and connect it through the use of neodymium magnets. When attached the user would then be able to achieve the desired task. Figures 1 and 2 show the prosthetic interface open and attached to the docking station as well as the locations for the various attachments.

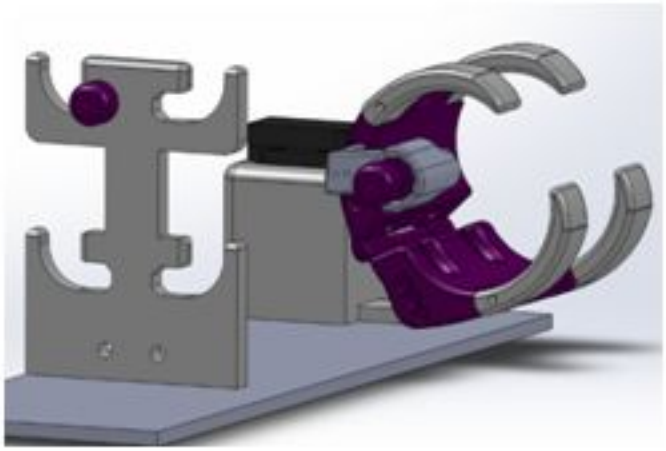

Figure 1 (Front Face of System)

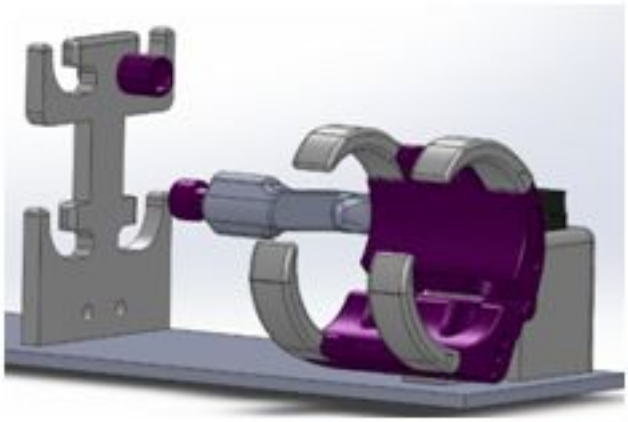

Figure 2 (Side View of System)

Figure 3 (Overall Assembled Unit with Attachments)

When the task is completed by the client, she would then be able to reverse the system and detach the attachment and reconnect the prosthetic interface to the docking station. In doing this she would slide the interface onto the tab and then apply a small force away from herself, locking the interface to the cabinet latch. This then gives her the ability to easily remove her arm.

A majority of the pieces were 3D printed and acetone was applied to blend the layers together which gave additional strength to the design. ABS 3-D printed plastic proves to be very strong, durable, and lightweight which made it an ideal material for this design. In addition to this, parts were printed in a matter of hours that have very intricate designs that may have taken machine shop days to manufacture. Overall, 3-D printing provides versatility, time savings, and a very cost effective solution to construct each unit.

EVALUATION

The device was evaluated on a continuous basis throughout the course of the project. Many different design iterations were made throughout the process to help improve upon the client's wishes and desires. One improvement in particular being the weight of the device as a whole and being reduced nearly

60% from the original unit design. In addition to this, an extensive effort went into performing Finite Element Analysis (FEA) testing to ensure each component was designed to the most efficient level. The overall lowest factor of safety found throughout this analysis was targeted at 3.9 which correlated very closely to our manual calculations of 3.8.

When giving the device to the client she was able to independently attach and detach the unit within a matter of minutes of brief training. Following this she was able to click into her writing attachment and write “Thank You” for us, and those being her first words in nearly 6 months.

DISCUSSION AND CONCLUSION

The developed prototype allowed the client to independently use the telephone along with eating, writing, and reading on her kindle. Currently, the client is using the device while her permanent prosthetic is being fitted. After seeing the impact that this device could have on someone’s life the group has decided to continue to develop the idea. Since the completion of the project we have met individuals within The Department of Veteran Affairs along with a number of prosthetic clinics in talks on introducing the product commercially into the prosthetics industry. In addition to this, the idea was submitted into the University of Toledo Business and Innovation competition and was awarded as the first prize winner. This award comes with connections from successful entrepreneurs in the industry, along with a cash prize to help fund the growth and development of the business. The overall goal would be to use this as a temporary prosthetic for the “In-between” stage of our clients’ amputations to when they actually receive their permanent prosthetic. With that being said, the overall design was focused around adaptability, scalability, and cost effectiveness knowing that this project could help thousands of people across the United States and the World!

ACKNOWLEDGMENTS

The client Sister Pat Taube was a wonderful inspiration throughout the project. Sister Pat really created a desire to go above and beyond the original scope of the project, and truly strive to create something that could help many others in similar situations. The College of Engineering at the University of Toledo provided unwavering guidance throughout the entire process. That being said

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