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Utilizing repurposed denim to create apparel for those with Cerebral Palsy

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Project Summary

Cerebral Palsy (CP) is the most common motor disability in children. In the U.S alone one million children and adults live with a diagnosis of cerebral palsy. Due to the increasing life expectancy of individuals with CP, the number of adults with this disorder is increasing, thus their medical and social care needs are changing (Moreno-De-Luca et al., 2012). For years children and adults who live with CP struggle in finding clothing that works for them and their needs. Currently the market for adaptable clothing is small. For people with CP, the lack of adaptive clothing creates large barriers whether it be mechanical, functional, cultural, or sensory related (Kabel, et al., 2017). The topic of sustainability is a pressing issue in the textile industry. The findings identified address the challenges associated with sustainable clothing practices, the negative impact of denim production, consumer consumption and product disposal on the environment. Methods of upcycling denim apparel that are both adaptable and eco-friendly are not only beneficial to the environment but for those with CP. Therefore, the study focused on identifying apparel needs of people living with CP and addressed these needs by creating two prototype garments using repurposed denim and altering the garments to be more functional. The prototypes were evaluated and modified, in order to ensure fit, comfort and functionality suited for people with CP.

Introduction

Background

Cerebral Palsy (CP) is a group of disorders that affect a person's ability to move and maintain balance and posture. Cerebral palsy is the most common motor disability in childhood. In the U.S alone one million children and adults live with a diagnosis of cerebral palsy. Due to the increasing life expectancy of individuals with CP, the number of adults with this disorder is increasing and therefore their medical and social care needs are changing (Moreno-De-Luca et al., 2012). Cerebral means having to do with the brain, while palsy means weakness or issues with using the muscles. Cerebral Palsy is caused by abnormal brain development or damage to the developing brain that affects a person's ability to control his or her muscles (CDC, 2020). The causes of CP are wide from prenatal, perinatal, and postnatal factors that can be present as single, isolated factors or as a combination of multiple potential risks. The severity of the motor impairment, along with other disorders, affects the functional ability of individuals with CP and also burdens the caregivers and healthcare system (Moreno-De-Luca et al., 2012).

Sustainability is a broad subject. The Brundtland report defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their needs" (United Nations, 1987, pg.1). In today's terms of sustainable development, it must balance how it meets human needs without degrading the natural environment. Meaning we do not take more than we need, so that something of our resources remains for our descendants (Worldenergy 2014). In 2015, the United Nations (2015) created goals for sustainable development by 2030. In Goal 12 it states, "Ensure sustainable consumption and production patterns" (United Nations, 2015, pg.1). The UN explains: "Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a

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better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty” (Ritchie et al., 2018, pg.1).

The clothing industry is a multi-billion-dollar industry, but for one million Americans with CP, a lack of options in the apparel industry presents daily challenges. Clothing is a fundamental part of our identities as individuals. For many people clothing is a way to express themselves or give them a sense of belonging. For years, children and adults who live with CP struggle to find clothing that works for them and their needs. For them, clothing has always been about functionality and not just a fashion statement. Fashion designers need to keep in mind there are specific needs that must be taken into consideration when creating clothes for those with CP. Currently the market for adaptable clothing is almost non-existent. According to Indiano (2019) lack of adaptable clothing may be due to a lack of visibility for people with disabilities which may stem from a lack of governmental protections, centralized research and motivation from the fashion industry to address the issue. For people with CP, the lack of adaptive clothing creates large barriers whether mechanical, functional, cultural, or sensory related. According to Kabel (2017), the lack of functional and mechanical clothing can hurt the overall well-being of individuals who are unable to present themselves according to their own standards. Other concerns such as, cultural and religious clothing related barriers may prevent people with disabilities from seeking assistance with apparel-related issues. For people with sensory disabilities, smart textiles are a need for them to perform everyday functions or they will be continuously bothered by their clothing. Clothing is such a basic and intimate need for everyone so why should those with disabilities be excluded?

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Definitions

Cerebral Palsy (CP)- is a group of disorders that affect a person's ability to move and maintain balance and posture (CDC, 2020).

Sustainability- relating to or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged (Merriam-Webster, 2020).

Sustainable development- is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 1987, pg.1).

Adaptable clothing- Any item of clothing that can be adapted for a person with any form of disability (Disabled World, 2020).

Recycling- to adapt to a new use (Merriam-Webster, 2020).

Upcycle- to recycle (something) in such a way that the resulting product is of a higher value than the original item: to create an object of greater value from a discarded object of lesser value (Merriam-Webster, 2020).

Downcycle-to recycle (something) in such a way that the resulting product is of a lower value than the original item (Merriam-Webster, 2020).

Repurposed- to give a new purpose or use to (Merriam-Webster, 2020).

Eco-friendly- not environmentally harmful (Merriam-Webster, 2020).

Accessible- easily used or accessed by people with disabilities: adapted for use by people with disabilities (Merriam-Webster, 2020).

Functional- performing or able to perform a regular function (Merriam-Webster, 2020).

Inclusive- broad in orientation or scope (Merriam-Webster, 2020).

Consumption- to spend wastefully (Merriam-Webster, 2020).

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Textile- a woven or knit cloth: a fiber, filament, or yarn used in making cloth (Merriam-Webster, 2020).

Problem Statement

Children and adults with CP struggle on a daily basis to find clothing that not only fits them but functions with their needs. Finding adaptive clothing is a huge problem considering how large the U.S. clothing industry is. There are few adaptable clothing manufacturers available to aid those with CP. For years, people with CP have had to improvise by either cutting holes in their clothing or replacing buttons with magnets. If more adaptable clothing were made, not only could it meet the need of those with CP, but it could meet the needs for those with other types of physical disabilities. Adaptive clothing could allow for those with special needs to be more independent while raising their self-esteem and confidence.

A large issue in the world today is the topic of sustainability, the idea of preserving and maintaining current environmental resources for future generations. Today the environmental cost of clothing production is immense. For example, many retailers have adopted fast fashion, which is the production of new fashion concepts, at a reduced price point, in a short period of time. The result of adopting fast fashion many Americans, some of the largest consumers of apparel items, throw away approximately 70 pounds of textile items per year. Such an amount of garbage is equivalent in weight to two hundred men's shirts, and most of this waste ends up in landfills (Londrigan, & Jenkins, 2018). The growth, manufacturing, and washing of cotton uses huge amounts of water, for example it takes about 2,700 liters of water to make just one t-shirt, this is enough water for one person to drink for 900 days (Londrigan, & Jenkins, 2018). Other pollutants in textile production are the use of pesticides in rate of growth, which are harmful to the land and not to mention the toxic chemicals from clothing dyes polluting our waterways.

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Niinimäki (2010) reports consumers in the developed world are well aware of the environmental impact of present industrial production and the impact of present consumption behavior. If we are to see any major changes towards a sustainable future, our cultural attitudes surrounding the consumption and disposal of fashion needs to change. The presented project extends the life of denim garments by repurposing them as adaptable clothing for people with CP.

The purpose of the study is to show how clothing can be adapted for those with CP, while also using sustainable practices. The sustainability aspect in the study is repurposing denim garments to create adaptable clothing for people with CP. The study will focus on different methods that can be applied to clothing in order to meet the needs and wants for those with CP. A design plan was developed with steps of how a used denim garment can be altered and made functional. The results of the study could provide better practices for sustainable clothing and could provide new designs of adaptable clothing.

Research Questions

The following questions guided the study:

1. What are the needs and preferences for clothing among individuals with CP?
2. How can clothing patterns and garments be physically altered to better meet the needs of those with CP?
3. How can repurposed materials such as denim be incorporated to create more sustainable and accessible garments?

Literature Review

Cerebral palsy is a group of disorders that affects a person's ability to move and maintain balance and posture. Cerebral palsy is the most common motor disability in childhood. CDC estimates that an average of 1 in 345 children in the U.S. have CP (CDC, 2020). Cerebral palsy is

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caused by abnormal brain development or damage to the developing brain that affects a person's ability to control his or her muscles. All people with CP experience problems with movement and posture. Many related conditions include intellectual disability, seizures, problems with vision, hearing, or speech and changes in spine or joint problems (CDC, 2020). Cerebral palsy is a lifelong disorder; approaches to intervention, whether at an individual or environmental level, should recognize that quality of life and social participation throughout life are what individuals with cerebral palsy seek, not improved physical function for its own sake (Colver, et al., 2014).

Clothing

Clothing plays an important role in our lives because it represents one of the basic physiological needs, which not only embodies our status within society but also provides comfort and protection against unwanted external factors (Curteza, et al., 2014; Esmail, et al., 2018).

Clothing becomes even more important when considering the needs of disabled citizens who are not only looking for comfort and fit but also functionality. Kabel (2017) reported that the clothing needs of people living with disabilities and impairments are not being met, the lack of appropriate clothing prevented individuals from fully engaging in social activities, employment or everyday life events. Clothing-related issues can create barriers to social participation and other desired activities for people living with disabilities and their families.

The design fields and apparel industry could play a vital role in helping people with mobility disabilities navigate these barriers. At the moment this research only found two companies that have made a line of adaptable clothing: Tommy Hilfiger and Target (Indiano, 2019). Both lines offer some great options but not enough to cover the large array of physical disabilities in the world, and there is a need for more options. When designing apparel for those with CP, garments have to allow more freedom and independence while being worn, be

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functional, be durable, be comfortable, and finally be both physically and psychologically beneficial to the wearer. Being born with CP should not mean an individual has to compromise a basic human need such as clothing, garments should be made easily accessible and adaptable to one's body.

Sustainability

The Brundtland report defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their needs” (United Nations, 1987, pg.1). As we shift toward a more sustainable future, consumers and clothing companies will need to normalize the design of sustainable clothing, increase the ease of purchase, and embrace recycling, upcycling and downcycling. However, sustainable practices may be tough to achieve considering the long supply chains of textile and fashion industries, and the norm of rapid consumption. To maximize sustainability in the clothing industry, the producers as well as the role of consumers and role of households are now important (Shim, Kim, & Na, 2018).

Recycling and reuse of materials is not new to the textile and apparel industry. Recycling is the breakdown of a product into its raw materials. In the textile and apparel industry, common examples of recycling collection and processing programs include recycling a product into its original form for example industrial scraps, then there is the process of melting post-consumer plastic products into a new product, another approach is pyrolysis/hydrolysis of polymeric waste and converts it into chemicals or fuels, and last you have recycling by burning solid waste and utilizing the heat generated (Muthu, 2016). There are many different types of waste out there, these approaches are a few ways we can recycle pre-consumer, post-industrial, and post-

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consumer textile waste. A well-known example of textile waste recycling includes recycling accessories and plastic bottles to make recycled polyester.

The term upcycling refers to the transformation of byproducts, unwanted products or waste material into new materials or products of better quality or better environmental value (Muthu, 2016). According to the US EPA (2020) textile waste occupies nearly 5% of all landfill space and textile recycle industry only recycles 15% of all post-consumer waste and leaves 85% in landfills. By using upcycling, to create something new and better from old or used or disposed items we can lengthen the life of that product. There are some challenges to upcycling for example negative views of upcycled products, the manual work that goes into upcycling products and textile waste disposal systems (Muthu, 2016). However, if these obstacles were overcome, upcycled garments can be a new market and apparel can be better sustainably. The presented project utilizes upcycling by repurposing denim to create apparel for people with CP.

Another eco-friendly recycling practice is downcycling, which is breaking a product down into its component elements. Once broke down the components are reused if possible as a much lower in quality product. For example, an old t-shirt can be reused as a cleaning rag or recycled plastic bottles can be made into a doormat. Downcycling gives a new life to a product that otherwise would be discarded. Thus, it is necessary to promote importance of practice and present a variety of practical ways to maximize our sustainability efforts (Shim, Kim, & Na, 2018).

Repurposed Denim

The quality of life for those with CP can be uplifted by improving the design and functionality of clothing. Dissimilar to a majority of the population, specific needs of people with CP vary according to certain requirements that are enabled by a particular necessity. Typical

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textile products that are created for people with disabilities can be far more expensive than their regular counterparts. The dimensions and design of adaptable clothing do not correspond to those of the standard products created for people who do not suffer from disabilities. Also, textiles must have special functions and be manufactured by using fabrics with these properties, such as tactile properties, thermal comfort, and ability to remove humidity (Curteza, et al, 2014).

When researching a more sustainable, inexpensive and functional textile, denim came to mind. Typically, denim jeans are thought of as stiff and rugged. They are irritating and trap in moisture making them uncomfortable. This project aims to use repurposed denim containing lycra or spandex. According to Nicholson et al. (2007) lycra garments are helpful for children with CP. Dynamic splints made from lycra are thought to reduce involuntary movements, increase proximal stability, and improve upper-limb movements in children with CP. Although the garments used in this project are not fully lycra, some lycra/spandex can prove to be useful in the breathability and stretch of the fabric. Also, the use of Lycra in denim is a viable option to solve the problem of recycling these blends, by upcycling into new products. Overall, denim is a non-gender specific fabric, comfortable and durable along with the added lycra/spandex. It is an optimal textile to use in adaptable clothing for people with CP.

Denim and Sustainability

Cotton is the raw material used in jean production and harvested all around the globe. To produce one kilogram of cotton, twenty thousand liters of water and pesticides are used in cotton cultivation. Due to unsustainable farming practices and heavy use of water, ecosystems and environments have been polluted where cotton is cultivated (Muthu, 2016). Denim jeans are usually made of cotton. An estimated average of 7,600 liters of water are required to create one pair of cotton jeans through cotton fiber and fabric production. That number does not include

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laundering the garment over its lifetime, which results in an amount that is even more staggering (Londrigan, & Jenkins, 2018). Apart from the large amount of water used to create a pair of jeans, manufacturing denim jeans requires chemicals used for finishes, toxic dyes, acid baths and sand blasting. Depending on the look of the jeans multiple treatments of dye and chemicals are used and the result is extremely harmful to the environment and society. The wastewater from denim industries is highly toxic and can kill plants, destroy ecosystems and poison drinking water. In Bangladesh one of the leading clothing exporter in the world after China, denim industries are constantly polluting their waterways. Due to the lack of government regulations, factories continue to dump wastewater resulting in dying fish stock, garbage filled waterways and pollution in the food chain. Bangladesh is not the only country where extreme environmental pollution from denim factories is happening. Locations in South West China are also having pollution issues (Muthu, 2016). The result of so many environmental factors are due to the increase of production and consumption practices of products. Recycling of waste is one way to prevent waste creation, extending product usage and life before being discarded into the environment, will undeniably be beneficial for us in the long run. Upcycling denim will not only transform the product for longer use but prevent unwanted waste materials into our environment.

Clothing plays such an important role in our lives, which embodies our status in society, provides comfort and protection from external factors (Curteza, et al., 2014; Esmail, et al., 2018). For people living with a disability it is much more than that, clothing for them not only needs to fit and be comfortable but functional as well. In the current market today, there is a lack of appropriate clothing for people living with disabilities. The quality of life for those living with CP can be uplifted by improving the design and functionality of clothing. As we shift toward a more sustainable future, adding recycled material is vital to prevent anymore waste entering our

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environment. When researching a more sustainable, inexpensive and functional textile, denim came to mind. This project aims to use repurposed denim containing lycra or spandex for comfort and stretch, then upcycling to be better adaptable for those with CP.

Development Plan and Design Process

The researchers analyzed the clothing needs and wants of people with CP and utilized the reconstructing of two repurposed denim garments and prototypes were made to address fit, comfort, and functionality. People with CP experience limitations with movement and posture. Many people with CP need to use special equipment to be able to walk, such as a specialized wheelchair (CDC, 2020). Therefore, the garments constructed were designed to allow better comfort and functionality for people with CP in a wheelchair. The garments constructed are easily made adaptable so anyone can construct the garments themselves. Materials collected from Goodwill in Fayetteville, Arkansas were used in creating the prototype and production of the denim top and bottom. The method to create the garments included finding a bottom and top garment which fit the wearer, making adjustments using other denim garments to be more adaptable and finalizing any alterations needed. To test the functionality of the designs, the researcher wore the garments for a day and a final evaluation was made.

The following steps were followed to create the prototype denim top and bottom.

1. For this project, three used denim garments were selected to create the prototypes
 - a. The bottoms were reconstructed using denim cutouts from another denim garment.
 - b. The top was made from a used denim garment and minor adjustments were made to be more adaptable.
1. Reconstruction of the denim bottoms
 - a. The denim pieces were chosen based on the fabric stretch and durability.

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- b. From another pant garment large pieces from the leg were cutout to create the long backing on the original garment. The higher waistband will prevent the pants from riding down while sitting.
 - c. The back pockets were removed and added to the front thigh area. This will allow more comfort in the back and better functionality for the wearer sitting down to access the pockets in the front.
 - d. To create the Velcro side seams, the original side seams of the pant were cut, and the Velcro was inserted along the seams. The side seams on the side will create easier access for the wearer to put on and take off the pants.
 - e. For the front closure of the pants, the zipper and button were removed, and the buttonhole was sewn closed. The Velcro was inserted along the flap where the zipper was originally located, and a small strip of Velcro was placed at the button location.
2. Construction of the denim top
- a. A used denim button-up top was altered by removing all the buttons and sewing the buttonholes closed. In place of the buttons, Velcro was added along the shirt front. This will allow the wearer greater ease when putting on and taking off the top. Two slits were cut parallel to each other along the lower abdomen of the shirt and finished off with red bias tape. This will allow access for a feeding tube; it can be opted out if not necessary for the wearer.

3. The final garment fit

The fit and comfort of the garments was evaluated on a model without CP. Finding a model was an issue due to the current pandemic and so the garments were fitted on the researcher. The garments were worn for an entire day to give recommendations on the comfort and functionality

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of the garments. A final evaluation of both garments was completed, and adjustments were made as needed.

Results

The result of the project presented easily made adaptable clothing that is not only functional for people living with CP but sustainable. The garments made are intended to aid people with CP using a wheelchair. To create adaptable apparel the garments were altered using repurposed denim. The steps provided allow ease of production for these garments that anyone can adopt. The garments were fitted to a model without CP, due to certain circumstances no models with CP were found. However, the research maintained valuable with the use of a non-disability person. Due to the coronavirus pandemic no models with CP were found, the researcher modeled the garments and was able to give valid feedback on the wear of the garments. The model wore the garments for an entire day seated for a majority of it, then a final evaluation was made of the fit, comfort and functionality of the garments.

Evaluation

The fit of the bottom garment proved to be a positive experience for the model. The added Lycra blend allowed optimal stretch and fit in areas needed. The crotch and waistband fit comfortably and did not tighten when sitting down. Elongating the back waistband was beneficial in the comfort level but adjustments to tighten it were needed for fit around the waist. The front waist band was at a decent height for the wearer sitting but may have been more comfortable if lowered by a half inch. Finding bootcut or wide-legged pants could prove to fit better for the wearer sitting down than the straight leg. Overall, the fit of the bottoms proved favorable for the model seated for a long period of time. Next, the fit of the top was evaluated which also proved to be agreeable. The top fit the model well and the added Lycra allowed extra

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room for stretch and movement. The length of the garment was long preventing the midriff area showing during certain movements. Addition of sleeves could prove to benefit the wearer from external factors. Overall, the fit of the top proved to be a positive experience for the model.

Results of comfort for the bottoms such as iterated in the fit analysis was a great experience for the wearer. The denim blend allowed comfort and stretch for the model sitting down for long periods of time. The long backing on the waistband prevented the bottoms from riding down when sitting. The removal of the pockets in the back and addition to the front allowed better comfort and practicality for the model. The Velcro side seams were hardly sensed by the model but for optimal comfort added fabric along the inside of the side seams could amplify better feel. To reiterate, the use of bootcut or wide-legged pants could allow better comfort for the model than the current straight-legged pant. If needed, added length to the bottom of the pants could provide extra coverage and comfort for the model. Overall, the comfort of the bottom garment proved favorable and beneficial for the model. Analysis of the top's comfort was also deemed successful. Since the garment was fitted to the model, she had no issues with the comfort. The added Lycra aided in optimal comfort and breathability of the top. The model suggested for people with shorter torsos, the garment length may have to be shortened for better access and comfort of the abdominal openings (if needed).

The final evaluation is the functionality of the garments for the wearer. The denim bottom allowed stretch and flexibility for the model. Thus, giving her the comfort while seated for long periods of time. The added elements of Velcro on the side seams made putting on the pants much easier while seated. The extra fabric in the back and removal of the back pockets allowed better comfort as well. The front pockets were deemed practical for the model to easily access and insert what she needed. Overall, the bottoms functioned properly for the model's

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needs. The functionality of the denim top was also positive, the blended fabric allowed stretch and breathability to the garment. The Velcro opening in the front made getting dress easier for the model while seated. If necessary, for the model the abdominal openings were perfectly located for the insertion of a feeding tube. Overall, the top functionality proved to be efficient and beneficial for the wearer.

Conclusion and Discussion

Cerebral Palsy (CP) is the most common motor disability in children. In the U.S alone one million children and adults live with a diagnosis of cerebral palsy. For years children and adults who live with CP have struggled with finding clothing that works for them and their needs. Currently the market for adaptable clothing is small. Methods of upcycling denim apparel that is both adaptable and eco-friendly could benefit the environment and those with CP

The result of this study present two repurposed denim prototypes made adaptable for those with CP. The steps given to create the adaptive apparel can be easily adopted by anyone. Certain alteration and fit consideration will have to be taken into account when designing these garments. For the denim bottom, finding a wide-legged pant would be comfortable for the wearer and fit much better. Additionally, the front waistband of the denim bottom could be shortened by half an inch for better comfort and less excess fabric in the front. For the side seams of the denim bottoms, stitching the Velcro in place will add that extra durability. Adding an extra layer of fabric along the inside of the side seams will prevent any feel of Velcro. These are a few alterations that can be made to the denim bottom for optimal comfort and functionality. One consideration when designing the denim top, is measure the torso of the wearer when sitting down and fit the garment by those measurements for better fit. Otherwise, the steps to alter the denim top can be easily done without complications.

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For this study, the final evaluation of fit, comfort, and functionality were limited to a model without CP. Due to the current pandemic a model with CP was unable to be found. However, the research is valid and more in-depth research remains because of the potential for this topic to further address the clothing needs and wants of people with CP, but also take into consideration the need for other physical disabilities. The design of this study could easily be utilized as a template for further investigation involving the production of adaptable clothing using sustainable methods. The methods utilized were validated, creating adaptive wear which can be easily implemented using repurposed denim, an important topic to discuss. Given the lack of adaptive wear available in the market for people with CP, it is vital that steps are taken to make adaptable clothing easily accessible and functional for the wearer. A better understanding of sustainable practices in creating adaptable apparel will lead to a future of less waste and more inclusive clothing for all.

Limitations and Future Research

For this study, the research was limited to a model without CP or any disability. Due to the current coronavirus pandemic finding a model with CP was arduous. However, the opportunity for more in-depth research remains valid because of the potential to further address the clothing needs of people with CP, and also take into consideration the clothing needs for other physical disabilities.

Furthermore, during the construction of the two denim garment prototypes there were a few unexpected fit considerations that need to be taken into account. The front waist band of denim bottoms needs to be lowered so when seated there is not excess fabric gathered in the front. The bottoms would also fit comfortably if they were wide legged rather than straight. The denim top length will need to be shortened so it lays comfortably for the wearer when seated.

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These were the only limitation; the project holds potential for designers and manufacturers to adopt sustainable practices and create more adaptable apparel.

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Appendix A: Sketches

Figure 1

Front Sketch of Denim Bottom Prototype

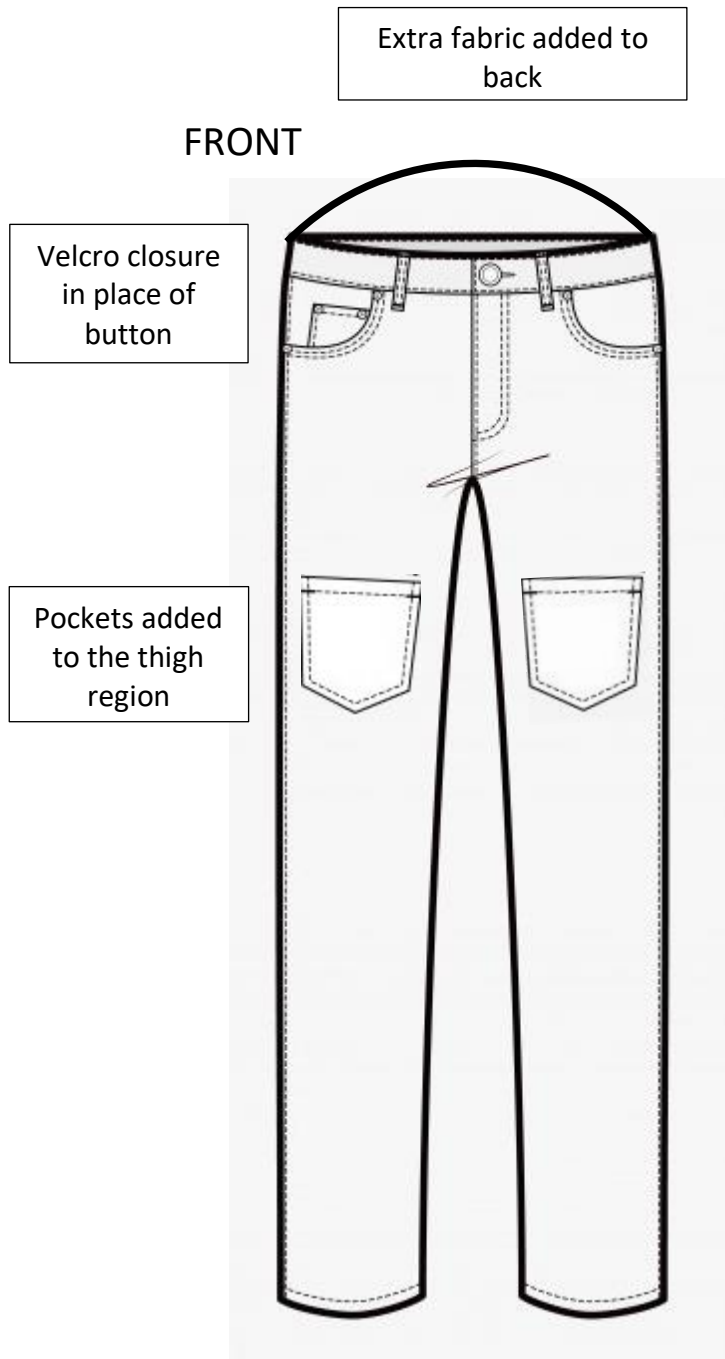


Figure 2

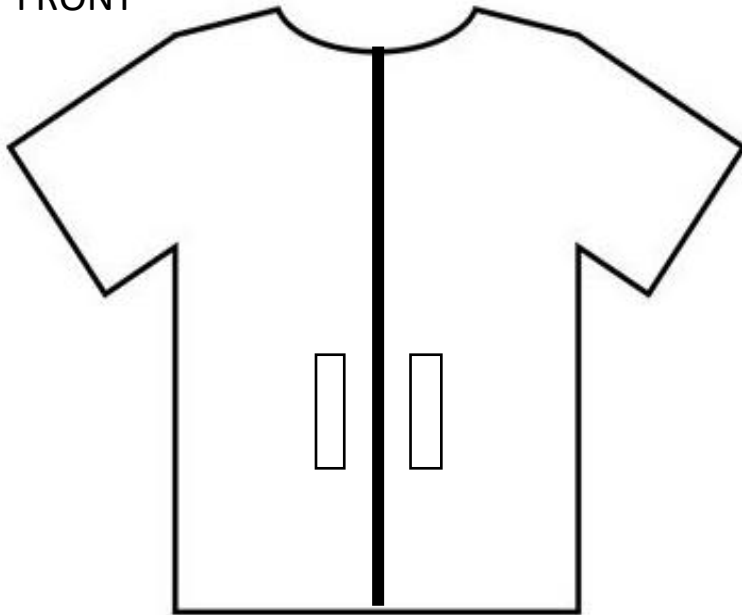
Back Sketch of Denim Bottom Prototype



Figure 3

Front Sketch of Denim Top Prototype

FRONT

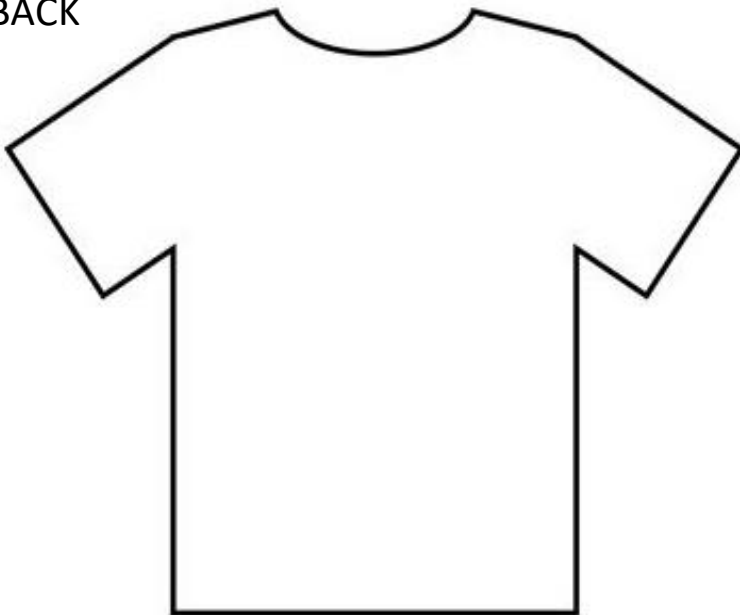


Front Velcro closure
and abdominal
openings

Figure 4

Back Sketch of Denim Top Prototype

BACK



Appendix B: Photos

Figure 5

Denim Bottom Prototype Left Side View



Figure 6

Denim Bottom Prototype Front View



Figure 7

Denim Bottom Prototype Right Side View



UTILIZING REPURPOSED DENIM TO CREATE APPAREL

Figure 8

Denim Top Prototype Front View



Figure 9

Denim Top Prototype, Collar Front View



Figure 10

Denim Top Prototype, Front View on Model

