

Adaptive Apparel Design

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Iowa State University Digital Press
Ames, Iowa



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*This is a publication of the
Iowa State University Digital Press
701 Morrill Rd, Ames, IA 50011
<https://www.iatatedigitalpress.com>
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CONTENTS

Introduction: A Guide for Adaptive Apparel Design and Soft Goods Product Developers	1
Chapter 1. The Adaptive Apparel Designer's Guide to Research	4
Chapter 2. The Adaptive Apparel Designer's Guide to Sketching	35
Chapter 3. The Adaptive Apparel Designer's Guide to Creating a Sample Notebook	41
Chapter 4. The Adaptive Apparel Designer's Guide to Creating a Mood or Inspiration Board	46
Chapter 5. The Adaptive Apparel Designer's Guide to Patternwork	52
Chapter 6. The Adaptive Apparel Designer's Guide to Creating a First Sample	60
Chapter 7. The Adaptive Apparel Designer's Guide to Creating the Completed Ensemble	66
About the Authors	69
Review Statement	70

Introduction: A Guide for Adaptive Apparel Design and Soft Goods Product Developers

The Need

More than one billion people, around 15% of the world population, have some form of disability (temporary or permanent) (World Health Organization, 2020). The adaptive clothing market is currently underserved in the apparel marketplace (Mallon, 2019). However, the adaptive clothing market is estimated to grow to nearly \$400 billion by 2026 (Gaffney, 2019). In the US, apparel retailers are launching brand extensions and offering adaptive apparel to aid disabled individuals with clothing options (Weinswig & Schmidt, 2021). Apparel design and soft goods product developers need specialized skills and knowledge to design and soft goods product development apparel for individuals experiencing a disability. There is a wide range of disabilities and students need to understand how specific disabilities impact a client's clothing needs. For example, many disabilities result in non-traditional body types/shapes or require the individual to be seated (Gaffney, 2019). Additionally, cognitive disabilities require understanding sensory apparel problems associated with fabrics, seams, or labels. Apparel designers and soft-good product developers need to be prepared to design for the adaptive apparel market and educators need resources to teach their students these skills.

Purposes of this Text

1. Empower current and future apparel design and soft goods product developers with information and resources to positively impact the lives of individuals experiencing a disability through clothing and other soft goods.
2. Provide students, educators, and working professionals with the specific knowledge and skills to design adaptive apparel and other wearable soft-good products.
3. Gather adaptive apparel design and product development information from disparate resources.
4. Create adaptive apparel design and product development resources where information does not exist.
5. Provide a holistic guide for client-based adaptive apparel projects, in apparel design and soft goods product development courses.
6. Support the implementation of client-based adaptive apparel projects in any apparel design or product development course and enable faculty to successfully teach this topic to their students.
7. Support students who elect to focus on adaptive apparel for their assigned apparel design and soft goods product development projects.
8. Support apparel professionals who want to design apparel for individuals with a disability.

Goals of this Text

- Increase apparel design and soft goods product developers' comprehension of creating for this market.
- Increase student satisfaction with their educational experiences.
- Prepare students for the important and emerging adaptive apparel and soft goods market.

Organization of the Text and How to Use

The text is organized around the apparel design and soft goods product development process framework. These steps include research, sketching, developing a sample notebook, mood or inspiration board, pattern work, first sample, and the completed ensemble. Users can read the text cover-to-cover or go to the specific section needed for wherever they currently are in their creative process.

A Resource for Apparel Design and Soft Goods Product Development Educators

Student learning experiences will be greatly enhanced by adopting the text in courses that apply the design and soft goods product development research process to create solutions that enhance the human experience. The text is ideal for courses where problem-based learning (PBL) and client-based project (CBP) approaches are utilized. Through these approaches, students interact with users to meet their needs, and gain practical experience solving real-world problems in the course of their work (Burns, 1990; Savery & Duffy, 1996). As these courses are structured to encourage creative freedom, the text can be used as a resource when designing for various adaptive requirements.

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Acknowledgements

We are thankful to doctoral student, Sunhyung Cho, for her research assistance with this book. Sunhyung created the croquis and illustrations of adaptive apparel notions that appear throughout this open educational resource.

We are thankful to the Iowa State University Miller Open Education Mini-Grant Program for financial support in the development of this book.

We are thankful to Abbey Elder, Iowa State University Open Access and Scholarly Communication Librarian, for ongoing support for efforts with project management, locating resources, and accomplishing review, design, and production work.

Chapter 1. The Adaptive Apparel Designer's Guide to Research

Introduction

Chapter 1 covers the first step of the design process—research, with specific attention to how it can be conducted for the adaptive apparel market. Types of research addressed include market analysis, consumer research, and materials research. In the section on market analysis, we provide a brief historical overview of adaptive apparel, identify major categories of available adaptive apparel products, and point out gaps in the adaptive apparel market. Resources that will aid designers in their research process include sections on (a) descriptions of disabilities and their impact on dressing and clothing needs, (b) an illustrated glossary of clothing adaptations organized by wearer's needs, and (c) a client communication guide. Finally, a section on selecting the right textile for adaptive apparel needs rounds out the research process.

Research: Collect Relevant Information

Apparel design research involves market analysis research, consumer research, and materials research. The following sub-sections will briefly describe how research informs and guides the apparel design process.

Market analysis

Market analysis research is important to the apparel design process as it helps the designer to understand what products exist in the market and gaps to be filled. Designers can use the internet to identify existing products and consumers' views of these products. Information may come from retailers' websites, customer reviews on these websites, and other social media or blogs.

Consumer research

Consumer research is important to the apparel design process as it helps the designer understand the potential product users and their needs. Designers can research the size of the market and user needs. They can use research data from government and organizations relevant to their product. They may also seek information directly from users through interviews, focus groups, or surveys.

Materials research

Materials research is important to the apparel design process as it helps the designer identify potential materials to use in the product. It can also help them evaluate and choose among material options. Designers may use the internet to identify retailers of fabrics and notions. Designers may utilize textile testing standards and methods to test potential materials for viability in the intended use. Information gathered in the market analysis, and consumer research may be useful in understanding what materials are currently used, how consumers evaluate them, and what unmet consumer needs may exist regarding materials.

Market Analysis of Adaptive Apparel Brands and Products

This section of the chapter will provide a brief overview of the history of adaptive apparel followed by brands that offer adaptive apparel and some specific adaptive apparel products, which are organized by adaptive need.

Brief historical overview of adaptive apparel

Adaptive apparel is uniquely designed for people with special needs or older people with difficulty dressing. More than 40 million people in the U.S. have a disability. Specifically, approximately 14 million have difficulties with essential daily activities such as dressing. Considering the marginalized population, designing and developing specialized apparel products can meet their particular clothing needs. However, the apparel industry has believed that the adaptive apparel market represents a consumer market with limited buying power and designs that require significant customization to accommodate the consumer group with disabilities. Recently, Tommy Hilfiger® succeeded in providing mass-produced adaptive apparel products and overcame the limitations. As a result, Tommy Hilfiger® launched the first mainstream adaptive apparel line for children in 2016. The mainstream apparel brand made unique adaptations to its existing manufacturing processes to ensure adaptive design innovations. After the success of the children's adaptive line, the brand expanded the adaptive line, including men and women.

Shortly after, with the growing awareness to include people with disabilities, other mainstream brands such as Target®, Nike®, or Zappos® entered this new market segment with their collections. Nike® introduced the Nike FlyEase shoe. Zappos® created the Zappos adaptive division for people with disabilities. Target® created the Cat & Jack children's wear line and has expanded its adaptive offerings into other categories including men and women. Currently, the adaptive apparel market is considered a relatively new, yet quickly growing market, and is estimated to continue growing to roughly a \$400 billion industry segment by 2026 (Gaffney, 2019).

Adaptive apparel brands

With growing awareness of consumers with disabilities, more and more brands, including mainstream brands, started to enter the adaptive apparel market. A wide range of factors influences adaptive apparel brands such as age, types of disabilities, or level of independence. Some adaptive apparel brands focus on older adults who experience severe levels of difficulties in dressing, so some of their products were designed for use of their caregivers. Some brands provide their own fashion collections to accommodate a particular consumer group such as wheelchair users. Future designers need to be prepared for a market encompassing diverse abilities. Researching the existing market for people with disabilities can provide examples and suggestions for adaptive features on clothing. The table below includes brands available online that offer adaptive apparel goods along with their current website links.

Brand	Website
Buck & Buck	www.buckandbuck.com
Care	www.careapparel.com
Abilitee	abilitee.com
Special Kids Company	specialkids.company
Independence Day Adaptive	www.independencedayclothing.com
Easy Access Clothing	www.easyaccessclothing.com
Lift Vest	www.liftvest.com
Professional Fit Clothing	www.professionalfit.com
Simplatex	www.simplantex.co.uk
Silverts	www.silverts.com
Specialty For You	www.speciallyforyou.net
Wardrobe Wagon	www.wardrobewagon.com
Tommy Adaptive	usa.tommy.com/en/tommy-adaptive
Zappos Adaptive	www.zappos.com/adaptive-clothing

Adaptive Apparel Products

There are different ways in which a designer can approach a design solution for adaptive apparel. Three of the major design adaptations commonly seen in the adaptive apparel market can be categorized as: (a) magnetic closures; (b) adjustable openings; and (c) fabric that supports sensory comforts. These three major categories are explained in more detail below, but other design approaches and considerations exist for specialized functional dressing needs.

Magnetic closures

Magnetic closures are one of the innovative approaches adopted by product developers in the adaptive apparel market. Wearers can effortlessly manipulate closures by replacing traditional buttons with magnets, making dressing easier. Magnets can be used with mock buttons to provide a classic appearance for such items as men's dress shirts. This design feature is especially useful for people with dexterity issues that limit their limb strength, speed, endurance, and coordination (e.g., arthritis).

Tommy Adaptive, the adaptive apparel line of Tommy Hilfiger, use this feature for easy open and close. The magnetic closures that discreetly hides magnets but represents the traditional button shape.

The magnetic zipper is also one of the innovative adaptive features. This magnetic zipping system (MagZip) enables people to easily zip with one hand. This feature helps people with low dexterity. MagZip is used by brands such as Tommy Hilfiger, Moncler, and Under Armour.

Adjustable openings

Adaptive apparel brands develop their products easily wearable by designing the openings such as pant legs, sleeves, and waistbands adjustable. Snaps, Velcro, or zippers are used make the openings easily adjustable. For example, wearers can easily get in and out of pants when the waist opening is wider with an extended side slit.



Image Source: (c) Silverts (www.silverts.com), included here for illustrative purposes under fair use.

Sensory comfort

Some adaptive apparel brands also focus on sensory comfort. Products currently available in the marketplace are usually made of sensory-friendly materials such as soft or stretchy fabrics or use flat seams and replace standard tags with tagless options to allow more comfort on the skin. Those apparel products target those with sensory issues who are sensitive to certain textures and materials (e.g., people with autism spectrum diagnoses).

Gaps in the market

Even though the adaptive apparel market is expected to continuously grow, the current offerings of the market are not diversified well, and their design options are limited. In addition, as the current adaptive market focuses on the needs of those with disabilities (e.g., wheelchair users), the market still needs to consider various clothing needs to include people with various types and levels of capabilities. Future designers need to understand diverse clothing needs of people with disabilities and to be prepared to create fashionable and functional clothing for all.

Despite the fashion industry's multiple commitments to and initiatives targeting greater diversity and inclusion, it's been slow to embrace adaptive fashion (Webb, 2022, para. 2).

Consumer Research: Background Research

The designer can understand the potential product users and their needs through background research on the size of the market and user needs. They can use research data from government and organizations relevant to their product. This chapter's information on disabilities' impact on dressing and clothing needs accompanied by an illustrated glossary of clothing adaptations can serve as an important source background consumer research as well.

Disabilities' Impact on Dressing and Clothing Needs

This section of the chapter outlines and discusses functional needs of adaptive apparel organized by

challenges or specialized functions that the user may need to perform daily duties. One example of functional need section includes openings in garments that may aid in donning and/or doffing due to low range of motion of the user. This section contains information as well as dressing challenges and design considerations for:

- low grip strength,
 - simple to use,
 - extra wide opening,
 - easy to reach,
 - sensory comfort,
 - thermal comfort, and
 - ability to hold medical equipment.
-

Functional need: “Low grip strength”

Disabilities and Clothing needs:

Various disabilities such as cerebral palsy, arthritis, muscular dystrophy, multiple sclerosis, or paralysis affect movement, muscle, and posture. People with those disabilities experience stiff muscles, exaggerated reflexes, lack of balance and muscle coordination, or writhing movements. The physical difficulties eventually impact dexterity associated with smaller movements that occur in the wrists, hands, fingers, feet, and toes. People with low dexterity have difficulty manipulating closures such as zippers or buttons.

Dressing Challenges:

- Decreased muscle strength impacts the ability to manipulate fasteners and closures.
- For example, some Velcro that requires a high level of strength to manipulate, because of their stiffness's, may not be easy to use for people with low dexterity or older adults who do not have strong grip strength.

Design Considerations:

- The use of a closure should not require much concentration and strength.
- The size and roughness of a closure affect the amount of force required to operate it. If a button or zipper pull tab is small and slippery, it is hard to grasp, hold, and manipulate them for individuals with moderate to severe dexterity difficulty.
- Protrusion, an extension of an object above the surface, also affects the wearer's ability to manipulate a closure. For example, a ring or piece of fabric attached to a zipper can help users detect and grasp the zipper slider and make zipping/unzipping easier.



A ring attached to a zipper slider.

Functional Need: “Simple to use”

Disabilities and Clothing needs:

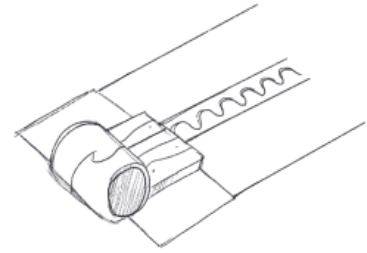
Cognition is holding attention, concentrating, processing information, or communicating and remembering. Autism, dyslexia, dyscalculia, or intellectual disabilities are related to cognition. It is recommended to avoid complex fastening mechanisms that require concentration and greater operating force to make garments as inclusive as possible.

Dressing Challenges:

- For example, hook and eye may require many steps of manipulation and higher levels of concentration. Therefore, manipulating the closure may be challenging for older adults or people with low cognition and dexterity.

Design Considerations:

- One of the principles of Universal Design is simple and intuitive use. The principle suggests that the use of the design should be easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
- Magnetic zippers require low concentration because the magnets of the closure enable them to automatically match the teeth and help the wearer easily pull up the zipper together.



Magnetic zipper.

Functional Need: “Open extra-wide”

Disabilities and Clothing needs:

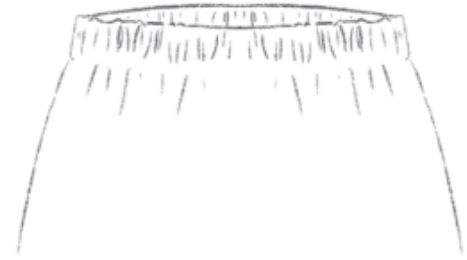
Many people with physical disabilities experience difficulty dressing. The dressing motion requires a high level of ability to balance, stand, and lift the body parts and extra concentration and effort.

Dressing Challenges:

- People with low mobility or low dexterity can spend an extended period of time to put on and take off clothing due to the need for additional support to stabilize or balance themselves or to use tool(s) to assist in dressing due to standard opening sizes in garments. This extra time spent in challenging dressing situations can lead to personal frustration and physical fatigue.
- Standard garment openings can also be a challenge for caregivers of people with low mobility or low dexterity as they assist the person with dressing. This can involve the caregiver moving limbs of the person or carrying the full weight of the person to put on or take off the garment. This extra physical load that the caregiver provides can be strenuous for them while also potentially putting the person they are providing care to in straining positions.

Design Considerations:

- Using stretch fabrics or elastic band on the entry points (e.g., elastic waistband) can accommodate greater movement flexibility.
- Adding slits or additional closures (e.g., snap closures at both shoulders) to the waist and leg opening can provide greater flexibility for easier body movement.
- Installing a full length of closures (e.g., snaps, Velcro, or zippers) on the side seam(s) can enhance the flexibility of the opening.



Elastic band at waist.

Functional Need: “Easy to reach”

Disabilities and Clothing needs:

People with disabilities such as cerebral palsy, arthritis, muscular dystrophy, and multiple sclerosis have difficulty in mobility due to the decreased ability of body, muscles, and posture movements. Additionally, people with limb differences have limitations on reaching.

Dressing Challenges:

- For example, the zipper located in the left side seam of a skirt may not be reachable to those with a right upper extremity amputation.
- If a pocket is installed at the bottom of a pair of jeans, the design feature may not be easy to use for those experiencing cerebral palsy.

Design Considerations:

- To make wearers easily put on and take off garments, closures should be located along an arc that the hand can reach quickly and without extra exertion.

Functional Need: “Sensory comfort”

Disabilities and Clothing needs:

People who have tactile defensiveness (or sensory sensitivity) are more sensitive to touch than others.

Especially, these symptoms may be experienced by adults and children with specific learning difficulties, learning disability, autistic spectrum diagnosis, or other developmental diagnoses. Those individuals may not like the feeling of certain fabrics or texture, tags or seams on clothing, or even wearing socks or shoes.

Dressing Challenges:

- For wheelchair users, back pockets may cause sensory sensitivity because they spend much of the time during a day with a seated position.
 - Additionally, back pockets can also lead to pressure sores that can lead to significant health challenges (e.g., hospitalization due to pressure sore infection).
- For adults and children who are neurodivergent, textile selection, construction (e.g., seam type), and labeling of apparel garments can lead to sensory challenges.

Design Considerations:

- When designing apparel products, protrusive elements (e.g., metal clips) or abrasive fabrics need to be avoided.
- For some sensory comfort needs, using compression materials may be desirable.
- Alternative construction/seam and labeling approaches (e.g., flat seams and tagless labels)
- Using stretchable fabric can facilitate ease of movement and wearers may feel more comfortable.



Tagless garment.

Functional Need: “Thermal protection”

Disabilities and Clothing needs:

Wheelchair users, when the temperature varies during the day, take more time than others to change their clothes or move into a building to maintain their thermal comfort.

Dressing Challenges:

- When there is a dramatic change of temperature, people who have paraplegia or are not able to feel the changing temperature in their body parts, especially lower extremities, cannot feel if they are

becoming too cold or hot.

Design Considerations:

- To regulate body temperature by preventing the transfer of heat, apparel products should use some fabric that can quickly react the thermal changes.
 - Garments that can be easily worn and removed are useful for those experiencing this challenge but also can properly protect body temperature.
-

Functional Need: “Ability to hold medical equipment”

Disabilities and Clothing needs:

Some individuals use medical devices and the device's tube or device itself needs to be associated with their clothing. For one example, Left Ventricular Devices (LVD) are surgically placed into the heart to keep the heart pumping for the individuals who are experiencing heart failure. These devices require that an individual carry a battery pack with them.

Dressing Challenges:

- There are currently apparel products that have been made to hold battery packs (for LVD, and other medical needs that require battery association) but these apparel products are limited in options and can be expensive.
- Additionally, proper garment that can be associated with the devices/or tubes is also limited.

Design Considerations:

- Adding pockets (e.g., in-seam pockets) and make a couple of holes on the existing garments can easily solve this problem.
-

Expert Advice for Design Adaptations by Disability: A User's Point of View

This content was provided by Morgan Tweed, CPACC. Morgan is an Accessibility Specialist in Architecture and Landscape Architecture. Morgan has participated as a client in apparel design class projects focusing on adaptive apparel.

General Advice for Design

People with disabilities have lives, events, and jobs. They don't want to look bad. Most clothing for people with disabilities tends to look like night clothes or hospital wear. Adaption doesn't have to look frumpy! Don't fall into that lazy trap.

Ask if they want to take visual attention away from their disability, highlight it, or ignore it as a factor. Some people want to be seen separately from their disability; some choose to embrace it. You don't want to make assumptions here.

Ask if they consider something an asset or an inconvenience. Example: A large-chested person may not want a push up bra.

Specific Advice for Design by Disability

There are many different design adaptations that may help depending on the situation. Below are some of the major adaptations that should be considered. Keep in mind that this is not an exhaustive list by any means, and everyone may have different needs. There are many other things to consider, but this gives you a good layout of some of the main things to watch out for.

Disability	Advice for consumer-friendly design
Vision differences	<ul style="list-style-type: none"> • For people with swimming vision, kaleidoscope vision, etc. Avoid complex patterns. • Avoid tripping hazards. • If they are legally blind, keep the hands free. Avoid billowy sleeves they might get caught on things. • For color blind and very to completely blind, have a tag or tactile marker on the clothing to describe the color would be helpful.
Deafness and Hard of Hearing	<ul style="list-style-type: none"> • Consider the use of their hands. Sign language will need the hands to be free and visible. Avoid sleeves that cover the hands. • Avoid shirts that match their skin tone, it will make signing harder.
Sensitive skin and skin conditions	<ul style="list-style-type: none"> • Avoid tight wear unless they say otherwise. • Comfort is key, but that doesn't mean they have to be frumpy. • Watch where you place seams and decorations. Comfortable fabric loses its comfort if scrunched or covered in backing materials. • Lace is not a good idea if it touches skin. • For some, quick to remove is important.
Neurodivergent	<ul style="list-style-type: none"> • Let them know about the design as it goes. Manage the expectation.
Wheelchair users	<ul style="list-style-type: none"> • Many wheelchair users have trouble with pants. The design is meant for standing not sitting, so it tends to cut into the stomach and back of the knees. Especially with stiffer fabrics. Flexible is usually favored. • If they need assistance with getting into their chair, you might be able to give them back some autonomy by making pants with easy to reach closures. • If they need assistance dressing, put the closures to the back of the garment. Shirts and dresses with overlapping free panels in the back make assisted dressing easier and takes less movement. • Remember to ask if they also sometimes stand or walk short distances. If so, don't design pants for just sitting, they will run into issues once they stand up like them ripping or falling off. Not the best look! • Pockets on pants are also rarely accessible in a chair. Consider alternate placements. • Jackets are hard to get on/off in chairs because of the seat back. Consider higher cuts in the back or free overlapping panels. • Sleeves can be a nightmare in a manual chair. They can get caught, get muddy, or cause you to lose your grip! Pay close attention to long sleeves and where they fall. Consider quick ways to pin sleeves up for changing conditions. • Similarly, to the sleeves, skirts can be a real nightmare, but people still want to wear them. Consider ways to pin the back to prevent getting caught in wheels. • Don't be afraid to take advantage of the seated position! A lap blanket can make one awesome accent item and be very functional.

Disability	Advice for consumer-friendly design
Other mobility aids and mobility needs	<ul style="list-style-type: none"> • If they have poor hand movement or lack digits, don't use dexterity heavy things like buttons to close. • If they don't want to hide their aids, design for them! There are unexplored fashion depths to including the aids. Most of what is currently available are the same 3 styles of bags for walkers and wheelchair in different fabrics. Not a lot of variety. • If a person is using an aid, that means that they have different mobility needs than other clients. Take their situation into account with a design. Don't restrict mobility further, don't make tripping hazards.
For size differences	<ul style="list-style-type: none"> • Remember that the world isn't built to accommodate differences. The areas that stick out more are more likely to wear down like knees and elbows usually do. Pick fabric accordingly.
For weight differences	<ul style="list-style-type: none"> • One size does not fit all. Simply enlarging a pattern will not make it appropriate for someone of a larger size. People with different weights are shaped differently, aim to flatter their shape. • If they have large breasts, fabric will not hold the same. More support will be needed. • Pick fabric and designs that can stand up to areas that may have chaffing. Don't put major seam joints in the spaces if you can avoid it. • People with different weights are shaped differently, aim to flatter their shape. Avoid scrunching at creases. Don't resort to making the clothes overly large to hide the person's body. This has the opposite effect. • If someone has a big belly, you will need to shape the chest differently to accommodate. If the chest is smaller than the belly, vests and jackets will be hard to come by, consider that when designing. • Clothing that breathes is important. • Freedom of movement, particularly with arms, tends to be restricted. • Seams and stitching may need to be tougher. They are dealing with more movement and more heft.
For unique shapes	<ul style="list-style-type: none"> • Forced symmetry will look off if the person is very not symmetrical. • Make sure your design doesn't restrict their actions.
For swelling	<ul style="list-style-type: none"> • Design areas where swelling can occur with more give/leeway.

Illustrated Glossary of Clothing Adaptations Organized by Wearer's Needs

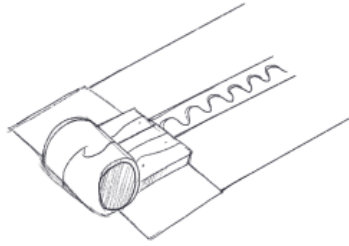
In the illustrated glossary of clothing adaptations section, figures have been created to help visually communicate apparel components or notions that can be considered in the apparel design process to address functional needs for adaptive users. These visuals are organized following the same structure as above a) low grip strength, b) simple to use, c) extra wide opening, d) easy to reach, e) sensory comfort, f) thermal comfort, and g) ability to hold medical equipment.

Low grip strength

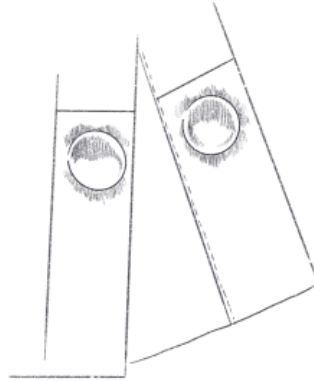


A ring attached to a zipper slider.

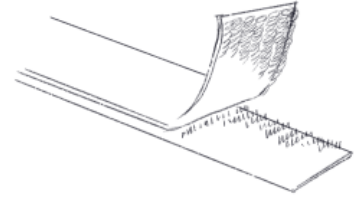
Simple to use



Magnetic zippers.



Magnetic buttons.

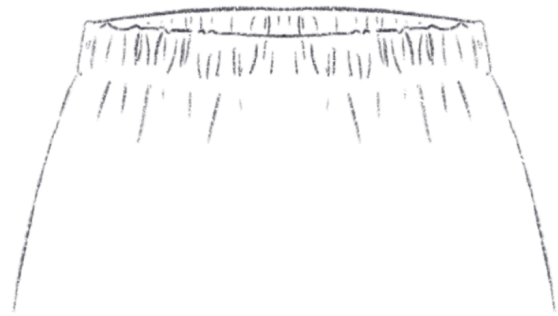


Velcro.

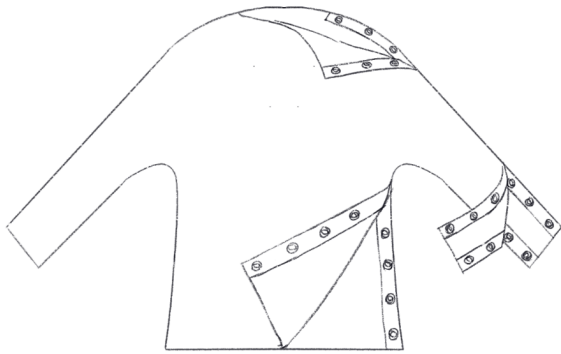
Open extra-wide



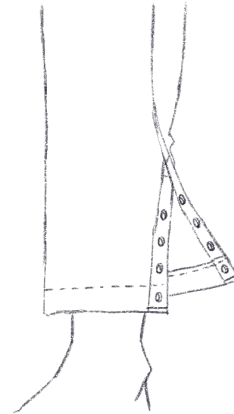
Snap closures on shoulder seams.



Elastic band at waist.

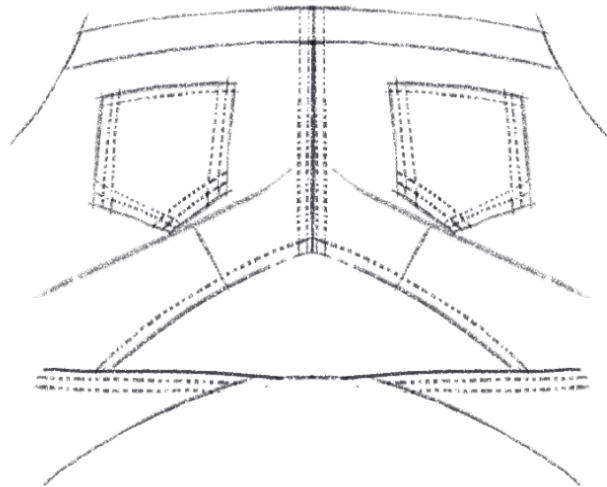


Snap closures on all the side seams.



Leg openings.

Ease of movement (lower body) – bend, squat, climb, etc.

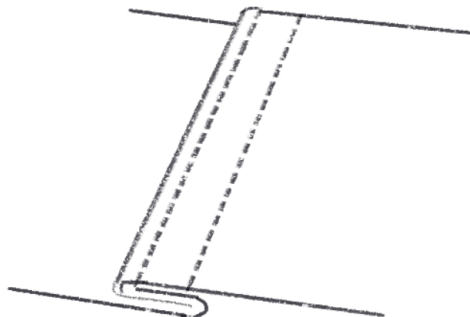


Gusset at the crotch.

Sensory comfort



Tagless garment.



Flat seams.



No back pockets for wheelchair users.



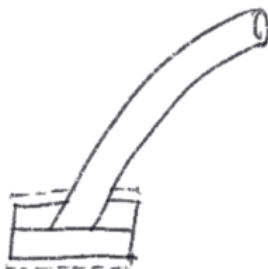
Back high-rise pants for wheelchair users.

Thermal protection



Poncho for wheelchair users.

Ability to hold medical equipment



Bound buttonholes for tubes.

Client communication guide, including use of person-first language

Language around adaptive apparel is something to be mindful of to show consideration to the person who has a disability. This section of the chapter discusses use of person-first language as well as a guides for interviewing persons with a disability.

People first language is used to speak appropriately and respectfully about an individual with a disability. People first language emphasizes the person first not the disability. For example, when referring to a person with a disability, refer to the person first by using phrases such as: “a person who ...”, “a person with ...” or, “person who has...” Below are suggestions on how to communicate with and about people with disabilities. Additional online resources are available through the [National Institution of Health](#).

People First Language	Language to Avoid
A person with a disability	The disabled, handicapped
A person without a disability	Normal (referring to a person without a disability as normal insinuates that persons with disabilities are not normal) person, a healthy person
A person who uses a wheelchair	Confined or restricted to a wheelchair, wheelchair-bound
A person with a physical disability	Crippled, lame, deformed, invalid, spastic
A person with cerebral palsy	CP diagnosis

General information about interviewing clients for adaptive apparel design

Interviews with clients with disabilities can expand a designer's knowledge of the environmental factors that affect the use of apparel products. Through the direct communication with interviewees, designers can gain a wealth of information of the problems involved. Defining the problems, as the first phase of the design process, can create an understanding of all the information acquired through research. This is one of the most critical tasks of designing.

According to Watkins and Dunne (2015), **three important factors** need to be clarified in order to define a functional apparel design problem:

1. Who are the users?
2. What is the activity?
3. What are the environmental conditions under which apparel will be used?

Then, specific goals for the apparel being developed (e.g., thermal protection, mobility) are stated and determined.

Novice interviewers often lead interviewees and thus prejudice their responses. What people do and what they say they do are often at odds; therefore, interviews may not provide accurate information. Designers need to be more professional, get trained for interviewing, and become familiar with appropriate interview techniques.

Specific information about interviewing clients with disabilities

- Use people-first language (e.g., “an individual with a disability” compared to “a disabled individual”).
- Speak normally, without patronizing the person.
- Disabilities can affect people in different ways, even when one person has the same type of disability as another person.
- Some disabilities may be hidden or not easy to see.
- Don't make assumptions regarding someone's capabilities or attitude toward their disability.
- Ask before you help.
- You may always ask a person how they would like you to refer to their disability.
- Wheelchairs, walkers, and crutches are mobility aids. Without the use of these mobility aids the person may be restricted from participation in their community.
- Assistive technology is a product or equipment used to increase, maintain, or improve a person's functional capabilities.
- Many blind, deaf, or persons who are hard of hearing consider the words “visually impaired” or “hearing impaired” to be offensive. Blind means without the sense or use of sight. Deaf means unable to hear. They do not wish to be identified as diminished in strength or value as the word “impaired” denotes.

Expert Advice on Conducting Consumer Research with People in a Disabled Community

This content was provided by Morgan Tweed, CPACC. Morgan is an Accessibility Specialist in Architecture and Landscape Architecture. Morgan has participated as a client in apparel design class projects focusing on adaptive apparel.

The following should be considered prior to any working session with the client, such as an interview, design session, or fitting.

Before the Meeting:

You should find out about their needs while you are working with them. The person that you are fitting might have never been in a clothing fitting situation before or have had clothes designed for them. Let them know what your usual process is then ask them what about that they might need changed.

- If they need to bring help them to maneuver and get around, this should be set up ahead of time.
- If they have parts of their body that they do not want exposed, set up expectations for what you need to access. They can wear more form fitting clothing or avoid certain areas.

A huge portion of adaption is respecting the time. Most disabilities take up time and effort. They must be scheduled around. Since, sometimes fitting and design sessions can take a bit of time, it is helpful to warn them of this additional time need in advance. This is very useful for:

- People that have neurodivergences know what to expect.
- People with timed medicines know if they need to bring medicines with them.
- People who have timed food, like those with blood sugar concerns or eating disorders.
- People that are dependent on others for travel.

The Meeting Space:

You want to make sure that they can get there and be comfortable in the space, so these are important things to consider:

- Is there accessible parking or public transit access?
- Is the path to get to the space is accessible to people who use wheelchairs and crutches?
- Are there tactile paths on the concrete?
- Is there is an accessible entrance with smooth paths, gentle slopes/ramps?
- Is there wayfinding?
- Are there signs with braille or high contrast?
- Are there automatic or button operated doors? If not, are they hard to open? You may need to go open them for your client.
- Are the doorways that they must go through are wide enough? (32" is standard) Do the doors have

high thresholds?

- Is the room large enough for a shopping cart to be turned around? This is a good way to visualize if someone can get a larger wheelchair in.
- Are there accessible bathrooms?

General Advice for Consumer Research Interviews:

Working with people in the disabled community, no matter what the field, is about respect, information, and adapting. No two people with disabilities are going to be the same. Even people with similar disability types might have different needs. So, before you get anything started, right off the bat, ask them what adaptations they'll need. But you can't put it all on them either. Prior to the interview conduct background consumer research of user needs. Conduct market analysis and materials research to understand currently available designs and materials. This will give you some items to discuss with your client and understand how they evaluate these potential solutions.

Don't use what you've learned from other disabled people you have met or designed for to claim you know what they need. It is never a good idea and feels dismissive. No two experiences are the same. Also don't assume a temporary experience like having a broken leg is the same.

Listen to them. If they aren't comfortable with the design or method, change it.

Specific Advice for Adaptations to Consumer Research Interviews by Disability

Once they are there and ready, there are many different adaptations that may help depending on the situation. Here are some of the major adaptations that should be considered. Keep in mind that this is not an exhaustive list by any means, and everyone may have different needs.

Disability	Advice for Direct Consumer Research
Vision differences	<ul style="list-style-type: none"> • There are all kinds of vision differences in the world, ask ahead of time what if anything they can see. Ask what they usually wear and prefer. • If they are color blind, ask which colors they can see. There are lots of spectrum charts you can look up to understand what they are looking at. • If they are color blind or completely blind, ask if they have a color preference in their wardrobe. Go with colors that go with more things. Bring fabrics that have different textures in those colors. • Bring physical examples instead of pictures. Descriptions are good too.
Deafness and Hard of Hearing	<ul style="list-style-type: none"> • Always look at them when talking. If they are lip reading, make sure to move your lips and not mutter. If they have a translator, don't talk to the translator, talk directly to them. If they are hard of hearing, speak up and clearly. Be patient about repeating yourself. • If you invite them and they need a translator. It is on you to get one.
Sensitive skin and skin conditions	<ul style="list-style-type: none"> • Just because someone has a rash, doesn't mean they are contagious with something. There are many conditions with an impact to the skin that are not contagious. • Ask what fabrics cause issues, which fabric they like. Bring samples. • Ask for the trouble areas and outline them in your notes.
Neurodivergent	<ul style="list-style-type: none"> • No two neurodivergences are the same. Ask about their needs. Encourage them to bring someone they know if they are nervous. The key is patience. Be prepared to take breaks. Don't take strong reactions personally. Many people in this category have some self-consciousness about their situation. • Break down what is going to happen before you do it. If you figure out later you forgot something, ask before changing the plan. • Ask about sensitivities and aversions. This includes emotional ones. Ask about phobias. You don't want to design a dress covered in pictures of butterflies only to find out they are deeply insect phobic. (Real story)
Wheelchair users	<ul style="list-style-type: none"> • You want to see what their ability is to get into and hold certain positions. This will impact how you can conduct a fitting and how you design the clothing. • Can they stand unassisted? Can they transfer to a chair? Can they lean? • Don't expect them to just "grin and bear" a position they say they can't do. • If there are belts and buckles, take pictures and measure where they lay. This will impact how your fabric is going to lay.
Other mobility aids	<ul style="list-style-type: none"> • If they have hyper mobility, find out where they need more give in their clothing. • Take pictures of points of contact where the client's aid touches them or hides an area. You don't want to put a great outfit element where it will be uncomfortable or hidden behind something else.

Disability	Advice for Direct Consumer Research
For weight differences	<ul style="list-style-type: none"> • In some country's health care systems, weight differences is viewed as a medical disability. Some people don't accommodate for weight differences and it can prevent access and ability to use certain adaptive apparel design solutions. • Respect weight differences in the same way a person in a wheelchair or a person with a different eye color would be respected. • Ask where they may be experiencing chaffing, likely as a result of their weight differences.
For unique shapes	<ul style="list-style-type: none"> • Remember to ask if they want to hide it/show it/ignore it. • Ask them if they use prosthetics or not. • Not everyone will want to hide an unusual shape or missing limb. Ask. • It is common for people in this category to do everyday tasks in a unique way. Ask them how they use their bodies. Unique limbs and stumps can still be used to do plenty.
For swelling	<ul style="list-style-type: none"> • Ask them where swelling can occur and how much. • Ask if they can bring something that they wear when swollen to compare.
Remember: If in doubt, ask, be respectful, be patient, and design <i>for</i> disabled people, not <i>around</i> disabled people.	

Materials Research: Textiles (Selection and Rationale)

In this section of the chapter, textiles (fabrics) are reviewed for considerations regarding selecting materials for adaptive apparel design. Additionally, resources for more in-depth information on textile performance and textile science are provided. A brief overview of the importance of selecting the right textile for worn products

Selecting proper textiles for designing apparel products considering people with disabilities is critical. The target consumer's lifestyle needs to be considered to understand how a garment will be used and laundered and its expected level of wear and tear. Especially, those people are often more sensitive to feel fabrics, especially those who have tactile defensiveness.

Textiles for adaptive apparel

Textiles are a flexible material consisting of natural or artificial fibers often referred to as thread or yarn. Here are textiles properties regarding adaptive apparel needs:

Thermal protection

One of the primary functions of textiles is to insulate the body to prevent transfer of heat. Improving the thermal protection of apparel products by adding layers or use fabrics of thermal resistance is essential. Concerning the thermal issues, people with disabilities, for example, wheelchair users might have some limitations in choosing outdoor apparel because they sit in a wheelchair, and it is difficult to react to the climate change. A combination of textile layers and the air gap prevents thermal energy transfer to the skin.

Comfort

The flexible nature of textiles is of great importance to apparel which needs to move with the human body. The need for increased ease through the armhole area and across the back to enhance comfort and mobility relative to the donning and doffing process is identified as another priority for people with disabilities. Easily stretchable/flexible or knitted fabrics are favored because stiff materials make donning and doffing difficult.

Easy care

Daily clothing tasks such as laundering, ironing, or storing garments is important for everyone. However, those are challenging for people with disabilities because of their physical difficulties. Some adaptive apparel brands use stain-, water-, or wrinkle-resistant fabrics, making it easy to care for the products.

Breathability

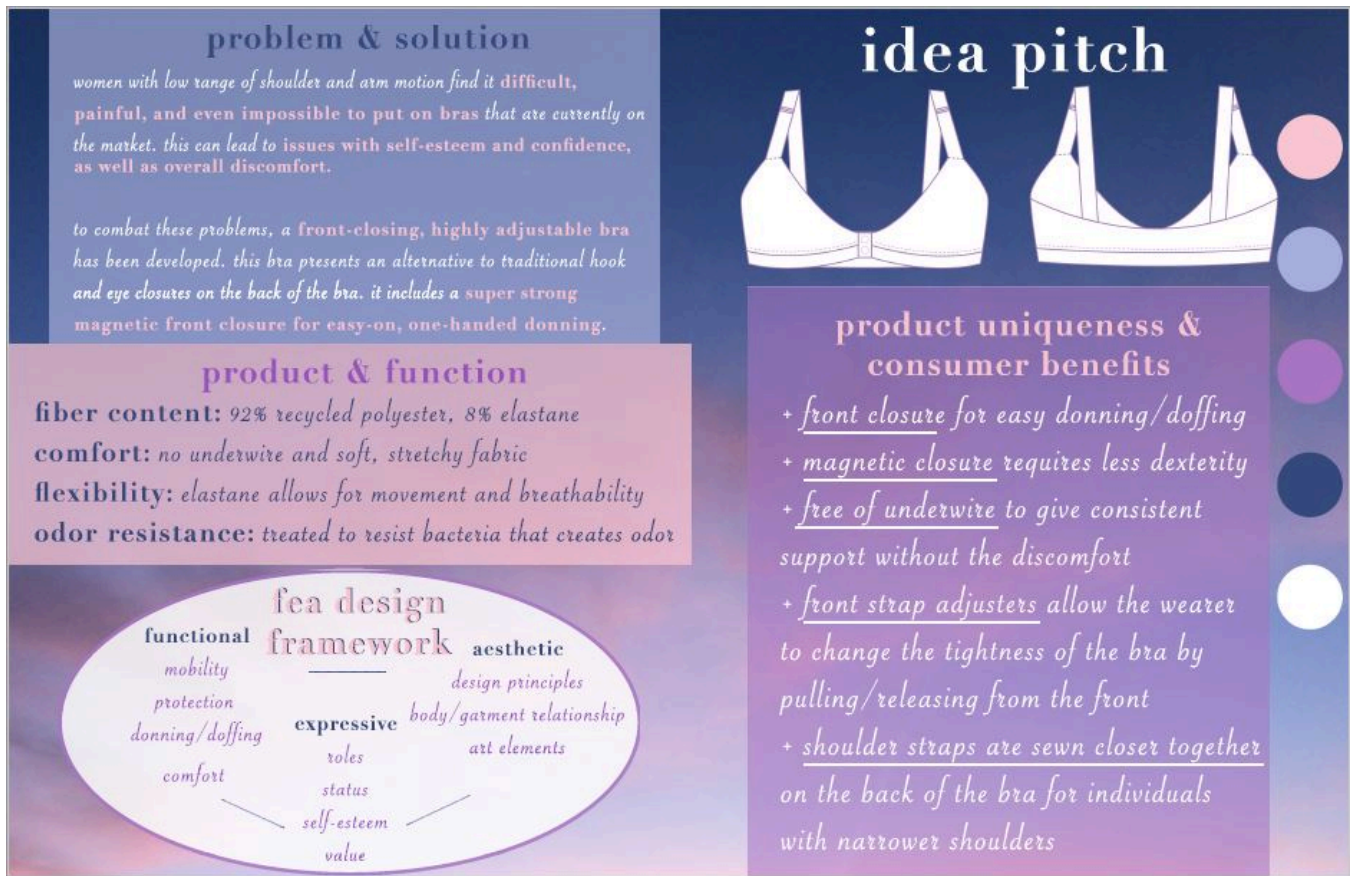
Fabric breathability is the ability to remove moisture created during perspiration (one of the most common problems), which implies optimal moisture absorption and air circulation. This fabric characteristic is critical for those who have disabilities and have difficulties changing their garments frequently or are vulnerable to heat or climate changes.

List of resources for more information about textiles

- [Complete Textile Glossary](https://www.fashiontrendsetter.com/downloads/Fiber_Dictionary.pdf) (https://www.fashiontrendsetter.com/downloads/Fiber_Dictionary.pdf): This PDF glossary by Celanese Acetate LLC is over 200 pages and offers detailed definitions for fibers and fiber-related processes as well as black and white illustrations.
- [Cotton Works](https://www.cottonworks.com/en/) (https://www.cottonworks.com/en/): The Cotton Works program is an industry resource for a professional or emerging professional in the apparel and textile industry. Develop expertise for every stage of product development and marketing by diving into our comprehensive resource with data and research, market and trend analysis, timely webinars, and informative videos.
- [Fabric Link, Fabric University, Course Curriculum](https://www.fabriclink.com/university/index.cfm) (https://www.fabriclink.com/university/index.cfm): This site provides general information about fibers including a brief fiber history page, fiber producers and trademarks, characteristics of textile fibers, a dictionary of fabric terms, fabric care tips, fiber identification through burn test instructions and consumer alert/fabric recalls. It also provides brief descriptions of 150 high-performance products listed alphabetically.
- [FIT Gladys Marcus Library – textiles](https://fitnyc.libguides.com/periodicals-by-subject/textiles) (https://fitnyc.libguides.com/periodicals-by-subject/textiles): Fashion Institute of Technology Library provides an organized list of periodicals, textbooks, or resources related to textile and design.
- [Textile Hive](https://www.textilehive.com/) (https://www.textilehive.com/): This site provides an online textile collective and archive.

Assembling Research

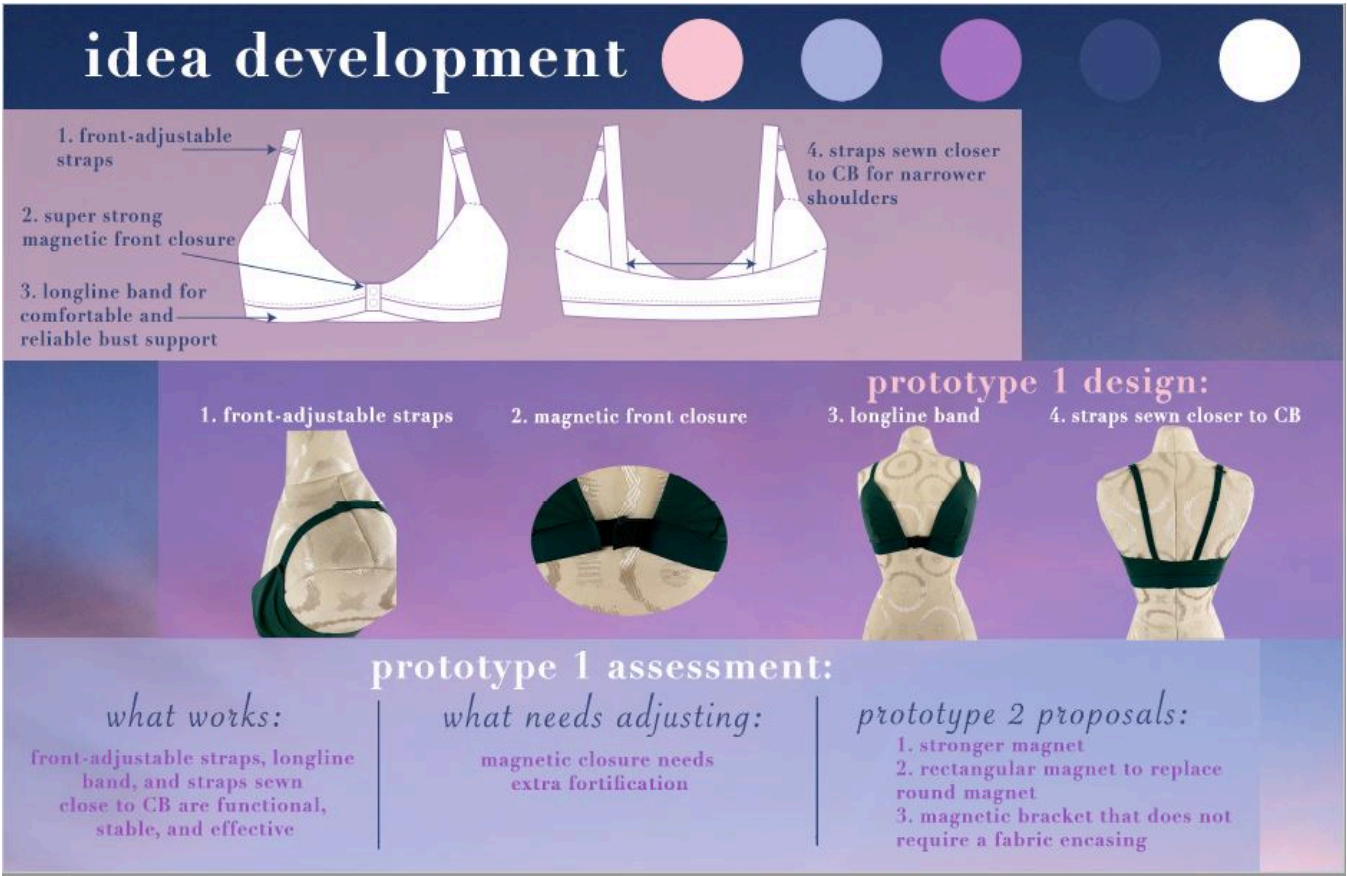
Once the designer has collected all the relevant research to inform future stages of the design process, they may find it helpful to assemble data into visuals to help them to not only remain focused during their ideation phase, but also to communicate their design justifications to other/stakeholders. Visuals can take on different forms, such as tables, charts, word clouds, technical drawings with call outs, or other dynamic graphics, or a combination of multiple visuals. Materials and visuals may be more informal, such as in a sketchbook, or more formal, such as a presentation board. Below are two visuals (presentation boards) that communicate design research conducted and how it informed the design ideation process and sample-making phase for an adaptive apparel design.



Idea Pitch board with summary of product problem and proposed solution; inclusion of guiding design framework; list of features that address user needs.

You can access a long image description for the visual above in the footnotes of this page.¹

1. An infographic with the title: "Idea pitch." Four major sections are presented: Problem and solution, product and function, fea design framework, and product uniqueness and consumer benefits. Problem and solution section: Women with low range of shoulder and arm motion find it difficult, painful, and even impossible to put on bras that are currently on the market. This can lead to issues with self-esteem and confidence, as well as overall discomfort. To combat these problems, a front-closing, highly adjustable bra has been developed. This bra presents and alternative to traditional hook and eye closures on the back of the bra. It includes a super strong magnetic front closure for easy-on, one-handed donning. Product and function section: Fiber content: 92% recycled polyester, 8% elastane. Comfort: no underwire and soft, stretchy fabric. Flexibility: elastane allows for movement and breathability. Odor resistance: treated to resist bacteria that creates odor. FEA design framework section: Functional: mobility, protection, donning/doffing, and comfort. Expressive: roles, status, self-esteem, and value. Aesthetic: design principles, body/garment relationship, and art elements. Product uniqueness and consumer elements section: Front closure for easy donning/doffing; magnetic closure requires less dexterity; free of underwire to give consistent support without the discomfort; front strap adjusters allow the wearer to change the tightness of the bra by pulling/releasing from the front; shoulder straps are sewn closer together on the back of the bra for individuals with narrower shoulders.



Idea Development Board with technical flat of proposed adaptive apparel design with callouts that address functional needs of user; images of fabricated sample; assessment for future design iterations.

You can access a long image description for the visual above in the footnotes of this page.²

2. An infographic with the title: "Idea development." Three major sections are presented: a technical flat of the proposed design, photos of the prototype design, and an assessment of the prototype. The technical flat design has 4 callouts: 1. front-adjustable straps, 2. super strong magnetic front closure, 3. longline band for comfortable and reliable support, 4. straps sewn closer to CB for narrower shoulders. The prototype design section showcases photos of the mockup, a simple black bra containing the elements mentioned in the first section. The prototype assessment section reviews what works, what needs adjusting, and proposals for a second prototype. What works: front-adjustable straps, longline band, and straps sewn close to CB are functional, stable, and effective. What needs adjusting: magnetic closure needs extra fortification. Prototype 2 proposals: a stronger magnet, a rectangular magnet to replace the round magnet, and a magnetic bracket that does not require a fabric encasing.

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Feedback Survey

We welcome your feedback as a user of this OER or potential collaborator on Adaptive Apparel Design work. Please [click on this survey link](#) or use your personal device to scan the QR code that will then link you to the online survey.



Chapter 2. The Adaptive Apparel Designer's Guide to Sketching

Chapter 2 focuses on sketching to develop potential concepts in apparel design. The chapter overviews how to use the resources provided in chapter 1 when sketching. Additionally, fashion illustration templates of bodies with disabilities are provided to aid in sketching. Croquis include seated bodies, amputee/protheses-user bodies, bodies using mobility aids, and bodies with spinal disabilities.

Sketching as a Method for Developing Concepts in Apparel Design

Sketching is the process of drawing a rough idea of how an apparel design may take shape. Sketching is a step in the apparel design process in which numerous design ideas are developed for further refinement and detail at a later point. The purpose of sketching is to produce a plethora of ideas for assessment before moving forward in the design process.

Importance of idea development through sketching

Sketching is an important stage in the apparel design process as this is when research is translated into visual solutions for apparel. Oftentimes, designers are encouraged to produce numerous design ideas through sketching using pencil and paper, but as technology advances, software and other digital tools have replaced traditional tools for this important idea development stage. But no matter what tools the designer chooses to use, documenting ideas are an integral part of the ideation phase to new apparel design, particularly when aiming to address adaptive users' functional needs.

Some designers find it helpful to use additional tools to sketch, including croquis and tracing paper.

How to develop ideas through sketching

Croquis

In apparel design, croquis are minimalist shapes taking on the form of a human body which serve as a blank canvas for which clothing idea can be drawn on top. Using a croquis allows for the designer to focus on apparel design ideas while keeping proportions of the human body form. Croquis can be used alongside traditional tools or more advanced technology digital sketching tools to keep body proportions of the user/wearer while generating numerous design ideas.

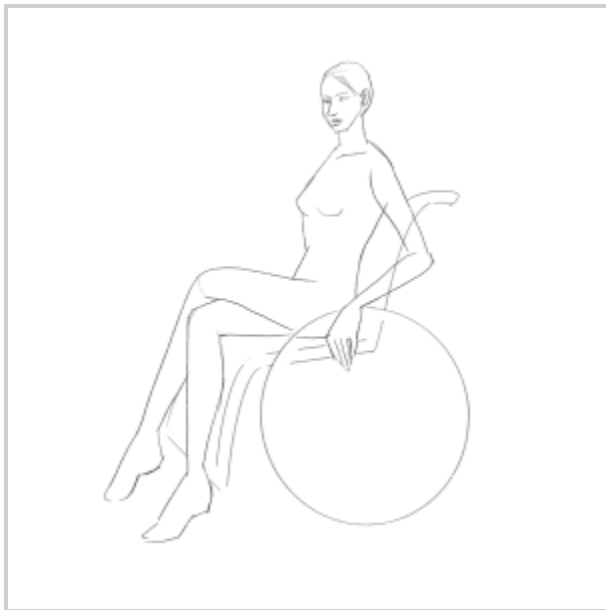
Tracing paper

Tracing paper is another tool that can be used alongside croquis and traditional tools for generating apparel design ideas in the sketching phase. Some designers may choose to use a layer of semi-transparent or opaque paper (i.e., tracing paper) on top of a croquis to speed up the ideation stage where apparel design ideas are only drawn (not including the body shape). Using tracing paper in conjunction with a croquis supports sketching in proportion with a body while also generating numerous apparel design options.

Fashion Illustration Templates of Bodies with Disabilities

In this section of the chapter figures of different bodies with disabilities have been prepared to aid the designer in generating design ideas. To support inclusivity in the design sketching phase, fashion illustration templates have been prepared in black and white croquis-style format for male, female, and child bodies. These figures are organized into the following sub-sections: a) seated bodies, amputee/protheses-user bodies, and bodies using mobility aids. While these croquis provide designers an alternative version of the traditional 9 heads fashion figure, these could also be adapted to 8 heads technical design croquis, truer to human proportions. Further, additional croquis could be developed to include a greater range of body shape and stature differences such as, but not limited to, dwarfism, Down's, progeria, and cerebral palsy.

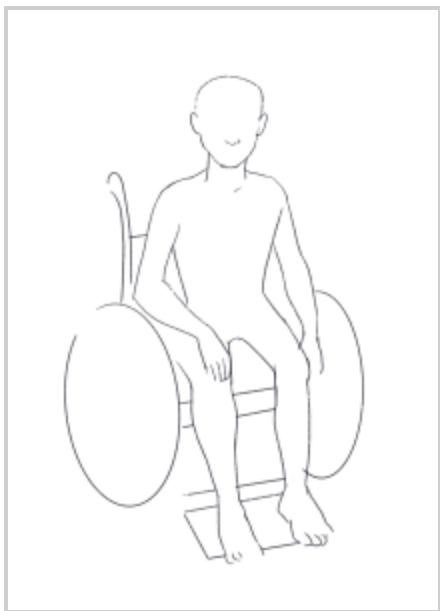
Seated bodies



Female with a wheelchair, side view



Male with a wheelchair, in $\frac{3}{4}$ view.



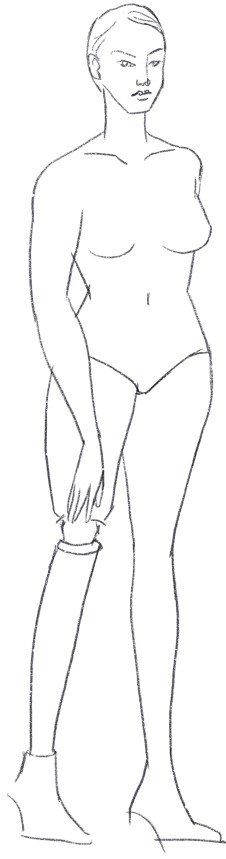
Child with a wheelchair, $\frac{3}{4}$ view



Female with a wheelchair, in $\frac{3}{4}$ view

Amputee/Protheses-user bodies

Lower extremity



Female with a prosthetic leg, $\frac{3}{4}$ view

Upper extremity



Male with a prosthetic arm, a back view

Bodies using mobility aids (e.g., crutches, walkers, canes)



Female with a lower limb amputation, using a crutch, a front view

How to use Chapter 1's [Market Analysis of Adaptive Apparel Brands and Products](#) while sketching adaptive apparel:

- Consider the research you collected in your market analysis research process using Chapter 1's Market Analysis of Adaptive Apparel Brands and Products. What are the gaps in the market you are

trying to address? What functional needs are you trying to meet? Review your research of existing products and how you would like to adapt or improve upon them. Use your research of various design adaptations. Use the sketching process to create multiple ideas around how these goals can be achieved. It is best to come up with as many ideas as possible. Sketches do not have to be of an entire garment. They may just be of a garment part—such as coming up with multiple ideas of how to close a cuff. Initial sketches can be rough or include as much detail as you need. The goal is to get the idea on paper! Doing so helps you keep track of your ideas and can serve as a communication tool with potential users of the product.

How to use Chapter 1's [Disabilities' Impact on Dressing and Clothing Needs](#) while sketching adaptive apparel:

- Use the consumer research you gathered using Chapter 1's Disabilities' Impact on Dressing and Clothing Needs to guide your sketching process. Through your consumer research you have developed understanding of the potential product users' needs. As discussed above, use the sketching process to create multiple ideas around how these needs can be met. It is best to come up with as many ideas as possible.

How to use Chapter 1's [Illustrated Glossary of Clothing Adaptations](#) while sketching adaptive apparel:

- Use the Illustrated Glossary in your sketching process as a jumping-off point. The illustrations can be referenced or even traced to start your original design sketches using the closure or design element, for example. Consider printing the illustrations out to use with tracing paper, or importing them into the digital drawing software of your choice.

Feedback Survey

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Chapter 3. The Adaptive Apparel Designer's Guide to Creating a Sample Notebook

Developing samples of potential patternmaking and construction techniques and potential materials is a key part of any apparel design or soft goods product development process. Chapter three overviews how to use resources provided in chapter 1 in the sample development process. Additionally, the chapter includes a sourcing guide to help users buy notions and materials for adaptive clothing.

Brief overview of using the sample notebook in apparel design

The sample-making process is an integral part of the apparel design process, especially for adaptive apparel design. This is because patternmaking and construction techniques used for garment assembly for people without disabilities may not apply for certain functional needs of people with disabilities. To ensure a good first sample and final product, it is wise for a designer to complete samples of the patternmaking and construction technique to feel confident that the proposed solution will work as planned. The sample-making phase also allows for practice of the technique so that when advancing onto a first sample, and eventually final product, the result will take shape and function as planned.

In the apparel design process, samples are often organized and assembled into a notebook for record keeping of the evolution of patterns or construction techniques. The notebook can be shared with others on a design team to build on the knowledge learned by one designer so that other team members can efficiently advance new patterns/techniques for future products. (Example of sample notebook structure below.)

While some may view the sampling phase as one that is time consuming and unnecessary, it is very beneficial stage to ensure a strong final product that functions as ideated in the sketching phase in addition to keeping record of the process.

Sample notebooks

Your sample notebook should include sections for the name of the technique used, date of completion, materials used, and process.

Download a [sample design notebook \[DOC\]](#) for your own use.

How to use Chapter 1's [Disabilities' Impact on Dressing and Clothing Needs](#) to develop adaptive apparel samples for your notebook:

- Review your collected design research for potential solutions. Create a list of construction techniques, materials, and notions you would like to experiment with. Create samples of multiple potential ways to construct the product so you can select the one that best meets your needs. Samples can include patternmaking and construction experiments. Often, half-scale samples can allow you to test the concept while saving time, space, and money. Samples may also be of a garment part. For example, you may sample different ways to close a sleeve cuff.

How to use Chapter 1's [Illustrated Glossary of Clothing Adaptations](#) to develop adaptive apparel samples for your notebook:

- Use the Illustrated Glossary of Clothing Adaptations to give you ideas and inspiration of how you might use the design features or specialized notions in your design. Consider including these illustrations as well as any related research within your sample notebook for easy future reference.

How to use Chapter 1's [Textiles \(Selection and Rationale\)](#) to develop adaptive apparel samples for your notebook:

- Review your collected design research to identify textile types appropriate for your intended target. Research potential construction methods that meet the design needs identified and that work with the planned fabrication. Construct multiple samples with various stitches and seams. Evaluate the samples with your client as well as through objective textile testing methods when appropriate. For example, is a particularly strong seam needed? Perhaps tensile testing is in order. Use your sample notebook to record all the details of your sample, including any client feedback or testing results.

Sourcing Guide

Once you have identified materials and notions you would like to sample for adaptive clothing, use this sourcing guide to find some resources for purchasing them. Please note that this sourcing guide is not exhaustive for notions that could be useful in your adaptive apparel design, but provides a starting point for sourcing. New materials and sources of materials are always being developed, so it is good to conduct your own sourcing research as well.

Where to buy notions for adaptive clothing

Magnetic zipper



One-handed zipper using magnets for individuals with dexterity issues. **Brand:** MagZip ([Link to magnetic zipper on Amazon](#))

Snaps



Snaps (plastic pictured). Snaps are available in plastic and metal. Plastic may be preferred if magnets are used in other areas of the garment. Metal snaps may be more durable. **Brand:** Dritz ([Link to snaps on Amazon](#))

Magnetic buttons



Buttons using magnets for individuals with dexterity issues. **Brand:** SEMINI ([Link to magnetic buttons on Amazon](#))

Snap tape



Snap Tape for easier opening. **Brand:** Dritz ([Link to snap tape at JoAnn](#))

Velcro



Two strips of thin plastic sheet, one covered with tiny loops and the other with tiny flexible hooks, which adhere when pressed together and can be separated when pulled apart deliberately. **Brand:** Velcro ([Link to velcro at JoAnn](#))

Double-fold binding



Double fold bias strip to make customized buttonholes for tubes or bound seams for sensory comfort. **Brand:** Wrights ([Link to binding at JoAnn](#))

Where to buy materials for adaptive clothing

Features of adaptive apparel fabrics	Suggested Fabric	Links
Highly adaptive breathability	Merino Wool: Breathes well, wicks moisture and is available in lightweight, summer-worthy styles. Doesn't retain odors like synthetic fabrics do.	naturesfabrics.com/collections/wool-fabric
Temperature management	Polartec's Windbloc: Good wind protection (ventilation rate of 50cc/cm2/ sec or less)	polartec.com/fabrics/weather-protection/windbloc
Sensory comfort	Fleece: Soft texture and attractive appearance	yourfleece.com
Sensory comfort	Tagless labeled garments and fabrics through heat transfer printing, pad printing, or screen printing	aspesite.com/blog/the-essential-guide-to-tagless-labels-on-garments

Feedback Survey

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Chapter 4. The Adaptive Apparel Designer's Guide to Creating a Mood or Inspiration Board

Chapter 4 covers development of mood or inspiration board for adaptive apparel projects. The chapter overviews how to use the resources provided in earlier chapters to create a visual reference point for the design process of selected concepts generated in the prior steps.

Brief overview of using the Mood or Inspiration Board in apparel design

A mood board, or inspiration board, is a visual that helps to inform and guide apparel design and sketch refinement before shifting into pattern work. The mood or inspiration board (or set of boards) are a visual culmination of the research and experimentation conducted in prior stages of the apparel design process. Some items included in a mood/inspiration board may include inspiration images, textile swatches and trims, color direction, typography, and any other images or objects that help visually communicate the essence of the design or collection. The mood/inspiration board(s) provide continual reminder for the designer of the design direction and help to keep the designer focused when refining their design ideas.

Mood/inspiration board can be crafted physically through finding images and adhering them onto a board, such as a foam core board, mat board, trifold, or wall-mounted cork board, depending on your resources, space available, and long-term needs of the boards, using a 'collage' approach. These boards can also be created digitally using software and digital images and other digital resources. Lastly, these boards can be created using a mix of tools, both digital and physical in a mixed-medium approach. No matter what approach a designer uses to create a mood/inspiration board, the end purpose is the same – to provide visual direction for their design(s).

Examples of a mood boards

Mood/inspiration boards can take on different shapes and include select information from the research stage of the apparel design process. Below are three examples of different mood/inspiration boards and how research can be communicated visually through imagery and text.

Childrenswear mood board



This example mood board primarily uses images to communicate the target consumer group, color palette, and textiles.

Swimwear mood board



This example mood board uses images and text to communicate target consumer, color palette, textiles and fabrication direction, and season for a targeted brand/label.

Magnet Bra mood board



This example mood/inspiration board uses images and text to communicate research conducted on target market and design opportunity in addition to color palette. See longer image description below.

You can access a long image description for the moodboard above in the footnotes of this page.¹

1. A moodboard with the title: "Adaptive intimates for women with injuries and disabilities: research and development." Two major sections are presented: target market and market opportunity. Target market: women with low range of shoulder and arm motion, making it difficult and often painful to put on a bra. Many different conditions can lead to weakness and low function in the arms, shoulder, and hands, including: injury, amputation, cerebral palsy, general aging, autism, multiple sclerosis, and more. A table labeled "Market Opportunity" with the caption "Traditional bras have back closures with intricate hook and eyes, as well as uncomfortable underwire and sub-par aesthetics." The table lists two problems and solutions. Problems: Difficulty donning and securing; Discomfort. Design solutions: Front super strong magnetic closure; Daily wearability, no underwire. A quote from a potential client is presented to the side: "It can be incredibly difficult on my self-esteem to ask for help when I need to put on a bra. It's such a vulnerable experience." Quote is attributed to Sal, 21, who suffered a rotator cuff injury.

Using your Research to Create your Mood Boards

Information gathered in the prior stages of the apparel design process is narrowed down and assembled into the mood or inspiration board (or set of boards). Chapter 1 provides resources for market research, consumer research, and materials research. All this information can be used to develop your board(s).

How to use Chapter 1's [Market Analysis of Adaptive Apparel Brands and Products](#) to develop adaptive apparel mood or inspiration boards:

- Use information you gathered from Chapter 1's Market Analysis of Adaptive Apparel Brands and Products to understand what products exist for the adaptive need your product addresses, consumers' views of these products, and market gaps to be filled. This information will help you focus down your collected research and decide what to include on your mood/inspiration board.

How to use Chapter 1's [Disabilities' Impact on Dressing and Clothing Needs](#) to develop adaptive apparel mood or inspiration boards:

- Use information you gathered from Chapter 1's Disabilities' Impact on Dressing and Clothing Needs to identify functional adaptive apparel needs for your market.

How to use Chapter 1's [Illustrated Glossary of Clothing Adaptations](#) to develop adaptive apparel mood or inspiration boards:

- Consider using illustrations from Chapter 1's Illustrated Glossary of Clothing Adaptations Organized by Wearer's Needs, which meet the identified functional adaptive apparel needs for your market, on your mood/inspiration board.

How to use Chapter 1's [Textiles \(Selection and Rationale\)](#) to develop adaptive apparel mood or inspiration boards:

- Use images or physical swatches of textiles selected in your research process using Chapter 1's Textiles (Selection and Rationale) on your mood/inspiration board. If the images of the selected textiles don't match your selected color palette, consider recoloring them digitally.

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Chapter 5. The Adaptive Apparel Designer's Guide to Patternwork

Chapter 5 focuses on pattern work for adaptive apparel. It covers patternmaking techniques useful for adaptive apparel and includes guidance for obtaining body measurements of persons experiencing a disability, including digital options. The chapter also overviews how to use resources provided in chapter 1—descriptions of disabilities and their impact on dressing and clothing needs and illustrated glossary of clothing adaptations organized by wearer's needs—to create adaptive apparel patterns.

Brief overview of using patterns in apparel design

In the patternmaking steps, designers and product developers develop patterns for the garments they will produce. Patterns are used as a guide in cutting out the fabric pieces to be sewn into the garments or soft goods products. Thus, they are an essential communication tool, and their accuracy is paramount. Patterns may be developed through a variety of processes, most commonly flat pattern or draping. Many books cover these techniques.

Guidance for Obtaining Body Measurements of Persons Experiencing a Disability, Including Digital Options

Taking accurate body measurements is one of the keys to provide great fit and comfort for wearers. Body measurements should be taken how garments are used, especially it is very critical for those who spend lots of time during the day in a seated position.

Tips for taking measurements of the seated body:

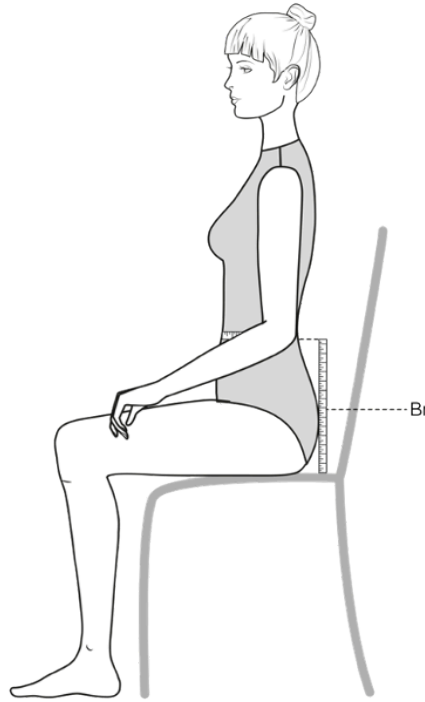


Illustration of taking a rise measurement while the individual is seated.
Image Source: [Mueller & Sohn](#). Used here for illustrative purposes under fair use.

- **All Measurements:** If possible, ask a caregiver for assistance in taking measurements, to make the client feel more comfortable.
- **Lower Body Rise or Crotch Depth:** Sit the client being measured on a flat surface, such as a hard chair, stool, or wheelchair, and measure along the side from the lower edge of the waist measure tape vertically downward to the seat of the chair. It may be easier to use a ruler for this measurement.
- **Hip:** Measure the hips at the fullest part
- **Inseam:** Measure the inseam along the inner thigh and calf, from just below the crotch to the knee and ankle with a seated position
- **Outseam:** Measure along the outer thigh and calf, from the waist to the knee and ankle with a seated position

Additional online resources for obtaining body measurement

- [Taking Measurements \(Mueller & Sohn\)](#)
- [ClothingPatterns101.com](#)
- [Girth Measurement of the Human Body \(TextileLearner.net\)](#)

3D scanning:

3D body scanning can provide effective technical solutions for the body measuring processes. Body scanning can be faster than hand-measuring processes as all measurements can be taken simultaneously. It offers the additional advantage of creating a permanent 3D record of the person's body, which the designer can reference later, without the client having to be present. Here are some tips to consider when 3D scanning an individual with a disability:

- To capture 3D body scan data, consider if the target customer can enter the limited space of a stationary full body scanning booth. Handheld scanners may be more appropriate.
- The customer needs to stand with arms and legs extended and hold the position for a short time (e.g., 5 seconds). The process might present barriers for customers with disabilities.
- To obtain a seated position of the customer (if the position is important for the apparel design), an assisting tool (e.g., a chair) is needed to avoid the data loss on the top and undersides of the legs.

Additional online resources regarding 3D body scanning can be found at [The 3D Body Scanner \(Cornell\)](#)

Expert Advice On Working with People in The Disabled Community for Measuring for Patternmaking and for Fittings

This content was provided by Morgan Tweed, CPACC. Morgan is an Accessibility Specialist in Architecture and Landscape Architecture. Morgan has participated as a client in apparel design class projects focusing on adaptive apparel.

Anytime you must touch their person, ask first. Autonomy is something that people tend to keep from disabled people. This is an important step in respecting your client.

There are many different adaptations to the measuring and fitting that may help depending on the situation.

Below are some of the major adaptations that should be considered. Keep in mind that this is not an exhaustive list by any means, and everyone may have different needs.

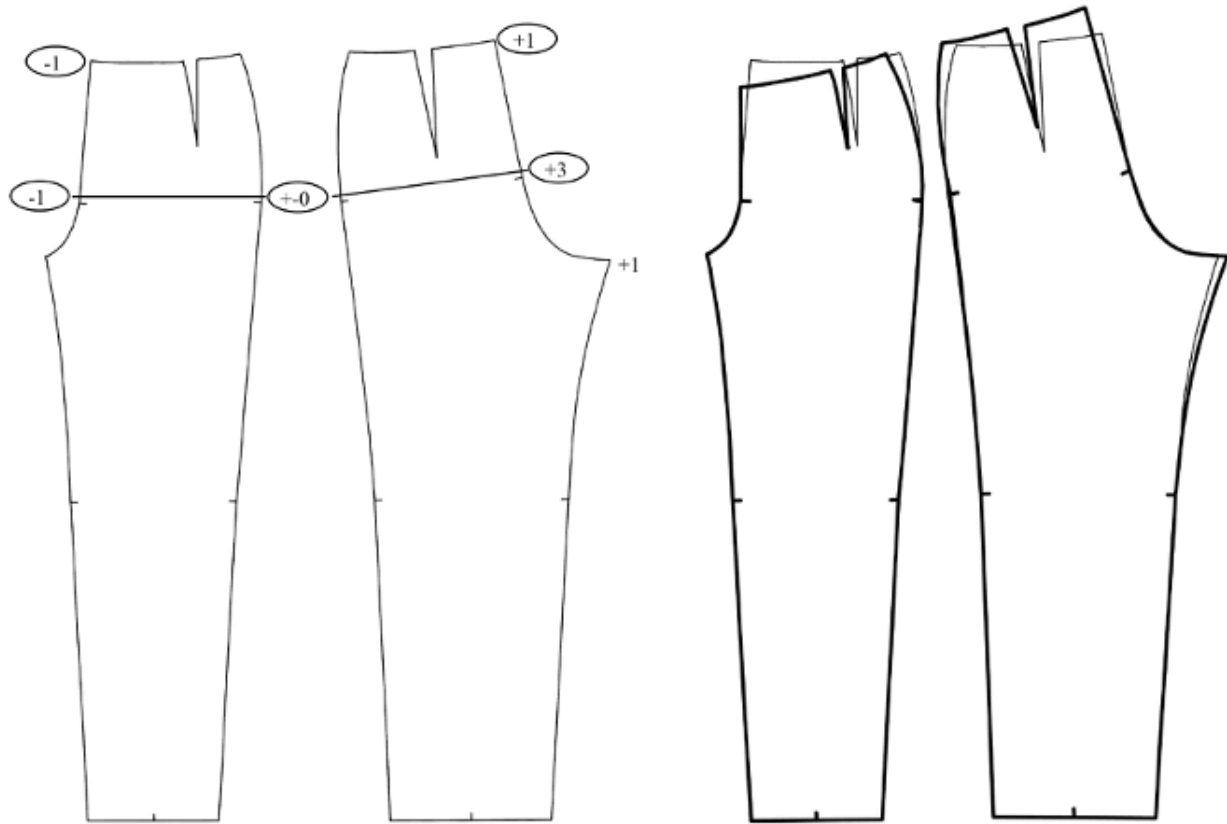
Disability	Advice for measuring for patternmaking
Deafness and Hard of Hearing	<ul style="list-style-type: none"> Show them that you are going to touch them before doing so.
Sensitive skin and skin conditions	<ul style="list-style-type: none"> Ask if any area hurts before measuring.
Neurodivergent	<ul style="list-style-type: none"> You may need to do measurements over clothing or instruct someone else to do the measurements.
Wheelchair users	<ul style="list-style-type: none"> When you are measuring, make sure to get the line of the lower back/butt/legs in the seated position. This will make a big difference to comfort. Measure the back of the shoulders with the arms extended forward. Most people have their arms down often. Manual wheelchair users are constantly reaching forward.
Other mobility aids and mobility needs	<ul style="list-style-type: none"> Ask them what their most usual postures are, and measure based on those. For example, if they use forearm crutches: The shoulder measurements are likely to be wider from an arched position.
For weight differences	<ul style="list-style-type: none"> Ask where they wear their waistline most often. Over or under the belly.
For unique shapes	<ul style="list-style-type: none"> If there is a unique shape, measure all the aspects you can to ensure comfort. If they are ok with it, take pictures. Not all unique shapes are obvious. Measure everything! Don't avoid measuring stumps, missing limbs, and unusual areas. If they wear them prosthetics the time, measure with it on. If they take it off and on, make sure it is accessible.
For swelling	<ul style="list-style-type: none"> Measure areas prone to swelling. Don't pull things tight to measure over swollen areas, it can really hurt.

Patternmaking techniques useful for adaptive apparel

The goal of this section is to identify changes from typical patternmaking techniques that can make clothing function better for individuals with disabilities. The table below identifies types of garment

adaptations, patternmaking techniques that can be used to achieve these adaptations, as well as how these techniques can help people with disabilities. The designer may wish to research additional specific patternmaking adjustments such as clients with shorter statures and spinal differences.

Types of adaptations	Patternmaking principles and techniques for adaptive apparel	Relevant clothing needs of people with disabilities
Increase garment rise	Modify the pant pattern for a seated position. Extend the length of the crotch on the center back and reduce the length of crotch on the center front. Also, the total crotch length is extended. (See the figure below.)	To provide enhanced comfort and fit in a seated position (for wheelchair users)
Easier opening	Apply Velcro and magnetic snaps for the fly front zipper of a pair of pants	To make the donning and doffing process easier
Easier opening	Extend the fastener (e.g., zippers or snaps) longer on the side seam or the entire length of side seam	To make the donning and doffing process easier
Easier opening	Add extra openings through dart manipulation and/or style lines to allow the garment to easily open	To make the donning and doffing process easier
Sensory comfort	Use or modify as flat-locked seams or inside-out seams	To provide enhanced sensory comfort and avoid sensory sensitivity
Sensory comfort	Remove tags	To provide enhanced sensory comfort and avoid sensory sensitivity
Sensory comfort	Modify patterns to minimize or remove seams at pressure points (by combining pattern pieces or moving seams to different locations)	To provide enhanced sensory comfort and avoid sensory sensitivity
Sensory comfort	Remove back pockets of pants	To provide enhanced sensory comfort and avoid sensory sensitivity
Storage	Create additional pockets which can hold medical items on existing seams or side seams	To provide additional storage for users with diverse needs
Storage	Attach pockets on the thighs or knees of pants	To provide additional storage for wheelchair users
Easier manipulation	Replace existing closures with adaptive closures (e.g., Velcro, magnetic snaps, magnetic zippers, snaps)	To provide easier manipulation of closures
Self Dressing	Add loops to waistbands.	To assist with holding the pants while pulling them up.
Garment comfort	Create an adjustable slit (e.g., zippers at the pant hem)	To provide comfort and mobility (for wheelchair users)



An example of patternmaking to increase garment rise.

How to use Chapter 1's [Disabilities' Impact on Dressing and Clothing Needs](#) to create adaptive apparel patterns:

- Review this section of chapter 1 with your user or target market's needs in mind. Note all their dressing challenges and design considerations that can alleviate these challenges. Make note of how you will adapt your patternmaking method to implement each desired design consideration. Jot down where you can look for information on completing that pattern alteration. This may be a printed book, web resource, or even an individual with expertise. After planning all your pattern-making steps, carefully consider if there might be any conflicts between the planned alterations. If you identify any, consider alternatives. You may to create and evaluate physical samples of various techniques to choose the best option for your project.

Client's Name:		Date:	Notes:	
	Dressing Challenge	Design Consideration	Patternmaking Method	Source of Information on Patternmaking
1				
2				
3				
(Add rows as needed)				
Potential interactions:				

Download a [Tracking Client Dressing Challenges template \[DOC\]](#) for your own use.

How to use Chapter 1's [Illustrated Glossary of Clothing Adaptations](#) to create adaptive apparel patterns:

- After deciding on your which design considerations are needed to address the identified dressing challenges, use these illustrations to help you visualize the patternmaking changes that will be needed. For example: "I can see that this specialty closure requires a different attachment method. Will my typical seam allowance work with this specialty closure?"

References and Resources

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Feedback Survey

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Chapter 6. The Adaptive Apparel Designer's Guide to Creating a First Sample

First sample development is a key part of any apparel design or soft goods product development process. This chapter provides construction techniques useful for adaptive apparel and helpful hints for fitting adaptive apparel. Additionally, the chapter overviews how to use resources provided in chapters 1, 3, and 5 to develop first samples of adaptive apparel.

Brief overview of using first samples in apparel design

First samples are garment prototypes, typically made of muslin or another low-cost fabric that is representative of the intended final garment fabric. First samples provide the product developer the important opportunity to evaluate the interaction of the planned pattern, construction techniques, fabrics, and notions in a prototype product or garment.

Creating a First Sample: Design & materials useful for adaptive apparel

How to use Chapter 1's [Disabilities' Impact on Dressing and Clothing Needs](#) to develop the first samples of adaptive apparel:

- Consider the specific dressing challenges related to your client's disability and identify design considerations for your design. If not already addressed in the patternmaking process, make sure that appropriate design elements, seam types, and construction techniques are included in your first sample.

How to use Chapter 1's [Textiles \(Selection and Rationale\)](#) to develop first samples of adaptive apparel:

- Review the descriptions of textile properties—thermal protection, comfort, easy care, and breathability—and decide which factors are most important when selecting fabrics for your garments or soft-goods products. Note key fabric selection criteria and potential fabric types appropriate for the first sample of your design.

How to use Chapter 3's [Sourcing Guide \(Where to Buy Notions and Materials for Adaptive Clothing\)](#) to develop first samples of adaptive apparel:

After identifying notions and fabric types appropriate to meet the needs of your client or target market, use Chapter 3's sourcing guide to source these materials to test in your first sample. Be sure to keep track of important sourcing information, so you can easily re-order if you decide to implement these materials in your final product. This might include:

- Fabric or notion name
- Source
- Garments used in/yards per piece
- Total yards
- Price per yard
- Shipping cost
- Total cost
- Delivery time
- Construction
- Fiber content
- Width

For your own projects, review: [Materials Selection Chart \[Spreadsheet download\]](#)

Creating a First Sample: Construction Techniques useful for adaptive apparel

Construction techniques useful for adaptive apparel can certainly vary with the specific needs of the intended target market. Considerations may include low-profile and non-irritating seam types for users with sensitive skin or seated body types. Other considerations may include seams with exceptional durability, such as a lapped seam. For example, this may be necessary for seams receiving extra strain due to the way the garment is pulled during donning or use. Coats provides a guide to seam types and their uses: [Seam Types \(Coats.com\)](#)

Seam type should be considered as part of the patternmaking process (Chapter 5), as different seams require different amounts of seam allowances to be incorporated into the pattern. Planned seam types can be tested in the sample notebook phase, as well as part of the complete product or garment as a first sample.

How to use Chapter 1's [Illustrated Glossary of Clothing Adaptations](#) to develop first samples of adaptive apparel:

- Use the illustrations of clothing adaptation to guide your construction of your first sample. For example, flat seams may be used to provide sensory comfort, or an elastic band may be used at the waist to allow the garment to open extra-wide. These illustrations may be incorporated into construction guides or specification packages.

Fitting a First Sample: Helpful hints for fitting adaptive apparel

A key part of the first sampling step is to fit garments on the client and correct the patterns as needed. The fit session may also uncover a need to use a different fabric, notion, or construction technique. This section covers fit sessions, what good fit is, and how to evaluate fit.

Fit Sessions

Fit refers to the relationship between the human form and the garment form. When fitting the garment on the model or client, fitters need to confirm that the initial design is appropriate for the design intent and fabric choice of the specific style. Through a fit session, the integrity of the design needs to be evaluated, based on the functionality or mobility of the garment. Here are what should be considered for a successful fitting session with clients with disabilities.

- **Space:** Make sure you have a separate area for privacy. Make sure the temperature is controlled. It is important to keep the fitting area well-organized and accessible for people with disabilities as they are our clients. The space for fitting should be adequate, for example, all tools be put away when not in use. Entering the space should be also easy and accessible.
- **Time:** The duration of a fitting session should be short, as client more easily get tired because of their physical disabilities.
- **Fitting Assistant:** Two fitters are better than one –position one in front and one in back–, each measuring, checking, and evaluating.
- **Hearing Assistance:** For those who are hearing impaired or offer audio translation, closed captioning services, etc. Make sure an ASL translator is available if necessary.

Fit

To achieve a good fit, a garment should be comfortable to wear and allows freedom of movement. Clothing should lie smooth, without wrinkling, pulling, or sagging unless it is intended. It should be easy to

wear and use, look proportional, and follow the design intent. Clients also can identify certain issues, such as whether the garment is hard to get on or off, if something feels off about the garment, or if it is itchy. Make sure to consider how the garment interacts with medical equipment or devices. This can include garment opening placement for tubes or cords from medical devices.

Fit Evaluation

Every body is unique. Especially when a client has a physical disability, it is important to note the client's body posture and shape. Here are the steps for evaluating a garment fit:

- Evaluate the proportional relationship of each area, front and back and side to side, to the previous area and to the whole of the body.
- Identify figure areas that may be larger or longer, smaller, or shorter than the average or ideal—body length, arm length, hip width, bust, and buttocks, and so on.
- Observe body conformation. You can determine the degree of angularity or curvature by the comparative amount and distribution of body weight.
- Identify specific variations that may influence overall garment appearance—angular hip bones, protruding abdomen, shallow chest, and so on. If you observe a variation in one area, examine other areas of the figure for a corresponding or related variation. For example, rounded upper back, resulting shallow chest or recessed collarbone, prominent shoulder blade.

Fitting Guidelines

- Side seams should be perpendicular to the floor (straight up and down), not swinging to the front or back, or twisting.
- The neckline should not pull to the front or back of the garment.
- Sleeves should be proportional to the length of the garment, and the design intent.
- Sleeve openings should not be too wide or too narrow.
- Garments should not have “whiskers” or “drag lines.”
- The crotch of the garment should not cut into the body or hang too low below the body (unless this is the design intent).
- Sleeves should not bind when arms move.
- Pants should not gape at the back waist when sitting.
- Pants should be comfortable to sit in, move in.
- Jackets should not be tight across the back when arms are crossed in front of the chest.
- Hems should hang parallel to the floor (unless it is an asymmetrical hem).
- Busts should fit comfortably in the garment: no drag lines between the apex of each breast, squishing of the breast tissue, etc.
- Bust darts should point to the apex of the breasts and should end roughly 1-1 ½” away from the apex of the bust.
- Waist darts should be parallel to the CF/CB of the garment.

- Shirt collars should roll nicely, rather than fighting to stand up or flay out flat.
- Buttons and zippers should be easy to use.
- Pockets should be proportional, functional, and easy to get into and out of.
- Hoods should not pull the garment up and away from the body.
- Hoods should have a nice shape, not pointy (unless that is the design intent).
- Do the design lines look proportional and intentional?

Fitting and Pattern Alteration Examples:

[Sewn Adaptive](#) is an education platform for tailors and sewers to learn alteration techniques to adaptive garments to make it more accessible to people with disabilities. Their video clips provide demonstrations of how to conduct fit sessions with clients with disabilities and how to adapt the existing garments.

- [Alterations to achieve a good pant fit for a wheelchair user](#)
- [Alterations to remove shirt wrinkles for a wheelchair user](#)
- [Alterations to shortening a jacket sleeve for an individual using a crutch](#)
- [Alterations to shortening sleeves for upper limb difference](#)

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Chapter 7. The Adaptive Apparel Designer's Guide to Creating the Completed Ensemble

Chapter 7 covers the last step of the design process— the completed ensemble, with specific attention to how designers can conduct it for the adaptive apparel market. Resources from chapters 1 and 3 are brought together to help the adaptive apparel designer sew the garments in the intended fabric, test effectiveness of planned materials, test effectiveness of planned construction techniques, and receive user feedback through interview, survey, and/or through wear testing.

Brief overview of completed ensembles in apparel design

In this step of the apparel design process, the garments are sewn in the intended fabric. Creating the completed ensemble is important as it allows the designer or product developer to test effectiveness of planned materials and construction techniques; and receive user feedback. This feedback may lead the designer to circle back to one of the earlier steps to improve the design.

Creating the completed ensemble

The tips provided below show how to use resources from chapters 1 and 3 to develop the completed adaptive apparel or soft goods products. These include finalizing the design, including materials and construction techniques.

How to use Chapter 1's [Disabilities' Impact on Dressing and Clothing Needs](#) to develop completed ensembles of adaptive apparel

- Consider the specific dressing challenges related to your client's disability and identify design considerations for your design. If not already addressed in the patternmaking and first sample processes, make sure that appropriate design elements, seam types, and construction techniques are included in your completed ensemble.

How to use Chapter 1's [Illustrated Glossary of Clothing Adaptations](#) to develop completed ensembles of adaptive apparel

- Use the illustrations of clothing adaptation to guide your construction of your completed ensemble.

For example, flat seams may be used to provide sensory comfort, or an elastic band may be used at the waist to allow the garment to open extra-wide for ease of donning and doffing. These illustrations may be incorporated into construction guides or technical specification packages.

How to use Chapter 1's [Textiles \(Selection and Rationale\)](#) to develop completed ensembles of adaptive apparel

- If not already completed in the first sample process, review the descriptions of textile properties—thermal protection, comfort, easy care, and breathability—and decide which factors are most important when selecting fabrics for your garments or soft-goods products. Note key fabric selection criteria and potential fabric types appropriate for the completed ensemble of your design.

How to use Chapter 3's [Sourcing Guide \(Where to Buy Notions and Materials for Adaptive Clothing\)](#) to develop completed ensembles of adaptive apparel

- After identifying notions and fabric types appropriate to meet the needs of your client or target market, use Chapter 3's sourcing guide to source these materials to evaluate in your completed ensemble. Be sure to keep track of important sourcing information, so you can easily re-order if you decide to implement these materials in your final product.

Gathering User Feedback

User feedback may be gathered in a variety of ways. The first step is to list the intended functions of the product and decide how to collect data to gather feedback on that function. It can be helpful to write out questions that you seek to have answered regarding your adaptive apparel design. This, in turn can inform what and how data should be collected. Pros, cons, and best practices for various user feedback techniques are discussed below.

Wear Testing

Wear testing can be useful in understanding the effectiveness of the design in meeting the user's needs as intended. User(s) can wear or use the product in its intended setting for a time that allows understanding of how it would work/function. This is more than just trying it on. Before the wear test, the user and designer should collaboratively produce a list of specific functions that the garment would serve and activities the user will engage in to evaluate those functions. For example, let's say a corset with magnetic closures was designed. The user and designer should consider what type of activities will be engaged in and for how long. Will they be sitting at a formal dinner? Getting in and out of a car? Dancing? This thoughtful preparation can optimize the wear test to give the most useful information about the design

as intended to use used. It is also good to plan ahead how the user's evaluation of the product will be collected. Interviews or surveys, discussed below, can be used, but other methods—such as user diaries are possible.

Interview, Surveys, and Focus Groups

If wear testing is not possible, potential users can still be asked to evaluate the product—either firsthand or digitally – through focus groups, interviews, or surveys. The designer should ensure that the wording is at the appropriate reading level for the target audience. Make sure not to use jargon that may be unfamiliar to people outside of the apparel industry. If necessary to use such terms, be sure to define them. The designer should also consider the usability aspects of interfaces. For example, this may include functionality with screen readers, translations, etc. See <https://www.w3.org/WAI/standards-guidelines/wcag/glance/> for further information.

Surveys offer the advantage of being able to reach a larger audience of potential users. However, if the survey is digital, rather than in person, it may not be possible for the user to evaluate the product 'hands-on'. Nonetheless, the product may be presented through photographs, 3D images, virtual reality, technical drawings, and written specifications. Interviews and focus groups can provide more depth in the users' evaluation as the interviewee can ask follow-up questions, based on the individuals' responses. Interviews and focus groups may be in person or digital (via remote video meeting platforms such as Microsoft Teams, Zoom, or WebEx), with the same product presentation factors as mentioned with surveys.

Gathered feedback may lead the designer to circle back to one of the earlier steps to improve the design.

Feedback Survey

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Review Statement

Adaptive Apparel Design was produced with support from the Iowa State University Miller Open Education Mini-Grant Program. In addition to production support from the university's Open Education lead, Abbey K. Elder, this book also underwent a peer review process with input from subject matter experts.

The review for this book was structured around considerations related to the text's usefulness as a teaching resource based on a rubric, rating the text on various aspects of its organization and content. The rubric was adapted from the [Open Textbook Library's Review Rubric](#). Following the peer review process, changes suggested by the reviewers were incorporated by the lead author and contributors.