

Adaptive Casual Shoe for Ankle Foot Orthotic Users

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Contextual Review:

There are limited shoe options for individuals who require the use of ankle foot orthotics (AFOs) for daily activities (Bulley, Shiels, Wilkie, & Salisbury, 2011; Spina Bifida Association, 2019). AFOs provide ankle stability and can help support foot and ankle movement. AFOs are typically fabricated out of moldable plastic and may or may not have an articulated ankle depending on the user's abilities. Despite their functional utility, there is a high rate of non-use or noncompliance in adults who own AFOs (Swinnen & Kerckhofs, 2015). Difficulty finding shoes that fit with AFOs is a key reason that users report non-use. Interview data, rehabilitation research, and online forums have reported that difficulty finding shoes that fit with the AFOs was the most frequently reported user perception (Civil, 2019).

There are several brands of sneakers available for consumers that are recommended by AFO users (Spina Bifida Association, 2019). Multiple commercial shoe brands have created sneakers with alternative entries, including rear entry and top entry, however several of the designs use zippers for closure. Zippers have a tendency to break, especially if placed on an angle with tension on the zipper. Sneakers that have a standard top entry, lace-up design with a wide toe-box are often recommended by orthotists (Orthologix, n.d.). To accommodate AFO width, many users will purchase shoes that are several sizes too large, with individuals who use an AFO on only one leg then requiring shoes of two different sizes. The commercially available shoes tend to be sneakers with functional or decorative laces. While some specialized shoe designs are available from medical supply stores, they are typically neutral colors and do not fit a broad range of users' aesthetic and expressive needs (Lamb & Kallal, 1992; Hall & Lobo, 2018). The purpose of this creative exploration was to design a pair of casual shoes that allow for facility of donning and doffing for an adult AFO user and to create a do-it-yourself (DIY) manual to allow users to create their own shoes and modify the fabric choices to meet individual aesthetic and expressive needs.

Concept:

Based on the first author's experience assisting with donning and doffing AFOs and shoes, as well as web searches of existing solutions, the novel solution is a semi-modular design. The toe box is separate from the medial and lateral segments of the shoe upper. The medial and lateral segments can detach from the toe box and open for top entry, and then are overlapped and secured to the toe-box resulting in a sleek appearance and easy donning and doffing.

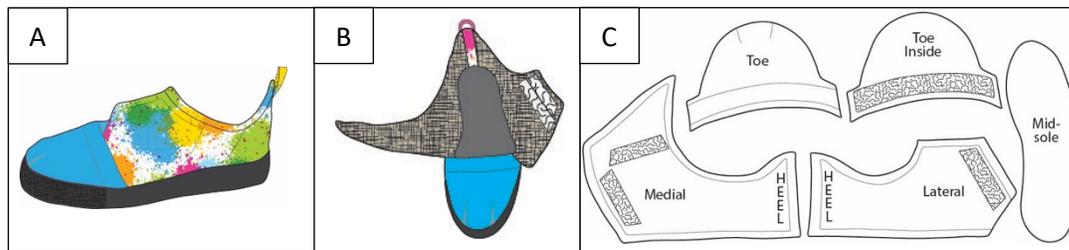


Figure 1. Ideation Sketches A. Side-view shoe alone B. Top view shoe alone with segments open. C. Pattern Pieces

Process, Technique and Execution:

Upper-Shoe: The 2D upper-shoe pattern was created based on a foot last made by wrapping duct tape on a volunteer user with foot size 8.5. The design lines of the shoe-upper were created, tested and modified with two AFOs that were loaned from a local orthotist. Both a right and left AFO were loaned, however the right AFO was made for an individual with a wider foot compared to the left AFO. Multiple iterations of the 2D pattern pieces were required to create shapes that could accommodate both widths, and also work for user who requires a single AFO. See Figure 1.D. for Patten Pieces.

The materials for the shoe were chosen for durability and style options and were selected from a fabric store chain to ensure broad community access to materials. Outdoor canvas material with a patterned design and a matching solid color were selected for the medial and lateral segments. Individual users could select from a variety of colors or patterns available at their local fabric stores. Pellon Flex Foam Stabilizer provided structure in the heel. Hook and loop fabric was chosen to secure the medial and lateral segments to the toe box based on the ease of fastening and fabrication. The first iteration of the design did not use interfacing ironed onto the medial and lateral upper segments and therefore the fabric tended to conform to the AFO. The design was modified to include interfacing and an additional canvas lining was added which allowed the shoe to maintain its shape. The toe box was also modified to include a second layer of canvas, and plastic corset boning strips were secured between the layers to keep the toe box elevated for ease of donning and securing the medial and lateral segments with hook and loop fabric. The shoe-upper edges were bound with bias tape created from the multi-colored fabric, and a heel loop was secured for donning the shoe. The shoe-upper was hand- basted then machine sewn to one layer of the foam, and the toe box was hand-sewn to a second layer of foam which made up the midsole.

Midsole: The midsole was built up with two layers of Pellon Flex Foam Stabilizer, and two layers of felt. Using two layers of foam allowed for simplified construction of the upper and added comfort for a user who is wearing only one AFO. Both layers of foam were glued together and glued into the outsole of the shoe, followed by a felt layer for aesthetics.

Outsole: The Margom Cupsole was purchased from Brooklyn Shoe Supply (Margom Cupsole, n.d.). The flat style of the sole is consistent with a casual shoe design.

Design Contribution and Innovation:

Wear testing of the design by a user without disability revealed that these adaptive casual shoes designed for AFO users could be donned in less than 12 seconds and doffed in less than 5 seconds by an individual. The semi-modular design with the fixed toe box and upper segments that wrap and secure to the toe box accommodates both the width of a foot without an AFO, and the width of multiple styles of AFOs. This functional design meets the needs of AFO users, accommodates multiple AFO styles, allows for ease of donning and doffing, and is able to meet the design aesthetic needs of multiple users. The materials and methods of fabrication are accessible for individuals in the community by following the DIY manual, which can be found at the following website: <https://sites.udel.edu/move2learn/how-todiy/>. Limitations of the design include the cost of the purchased outsole and the use of hook and loop fabric as a fastener, as hook and loop fabric can wear out, or become dirty and therefore decrease the durability of the shoe. Future designs could add elastic within the heel collar to improve the fit of the shoe without wearing an AFO, especially for individuals who only require an AFO on one side and could explore outsole options that are more affordable and wider at the toe box toe to further improve the inclusivity of the design.

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