Precision Redefined: A Pilot Study on Customized Half-Scale Maternity Dress Forms for Accurate Draping

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Introduction. During pregnancy, the female body undergoes significant physical changes in a relatively short period (Soma-Pillay et al., 2016). These changes are not limited to the abdomen, as the chest, hip, upper thigh, and mid-thigh circumferences also expand, along with the breadth of the hip and thigh (Jiménez & Bacallao, 1995). Unfortunately, current dress forms in the market fall short in representing the physical changes of pregnancy, except for the abdominal measurement differences, which conflict with the other body alterations. Some apparel companies have collaborated with Alvanon to create maternity dress forms tailored to their target market's specific sizing systems. However, these custom dress forms are not readily available for purchase.

Research Purpose. This gap in the market has inspired research to propose a renewed approach to fabricate half-scale dress forms that more accurately reflect curved body shapes, specifically looking at the body shape of a woman's pregnancy. Additionally, this study explored using 3D body scanning technology as a tool to visualize reliable anthropometric data measurements (Kiron, 2021) in order to generate a 3D avatar for assessing accurate body shape and measurements in a virtual environment (Apeagyei, 2010). The study builds on research by Vuruskan and Ashdown (2017) and contains three main objectives: (1) use 3D body scanning technology to capture the body shapes and measurements of a pregnant woman in their 5th, 7th and 9th months, (2) experiment with two types of foam to create a half-scale maternity dress form for the 9th-month body scan, and (3) utilize virtual fitting technology to evaluate the shape of the two fabricated dress forms to identify the most suitable material and method for achieving accurate body measurements and shapes. By achieving these objectives, the outcomes of the project provide a more accessible and affordable option for small businesses and educators to create maternity dress forms that can then be used to design and create maternity clothing (or clothing/soft-products for other markets that may require customized clothing).

Methods and Procedures. *3D Body Scanning and Data Processing.* A participant, who wore a U.S. size small, was recruited during her second trimester of pregnancy. The researchers provided her with a pair of biker shorts and a bra top based on her sizes. During her 5th, 7th, and 9th months, she was body scanned using the Human Solution 3D body scanner, which utilizes laser triangulation technology to ensure precise 3D measurements. The 9th month 3D scanned body shape was chosen to move forward in the research project. Multiple software was used for data processing to make the half-scale dress forms, such as Anthroscan, Meshmixer, Slicer for Fusion 360, and Adobe Illustrator. *Materials Testing by Laser Cutting.* The materials that were tested included a ½ inch wide Polyurethane (PU) foam sheet (Vuruskan and Ashdown, 2017) and a ¼ inch wide Polyethylene (PE) foam sheet. Each sheet of foam was placed into the bed of a Trotec

400 Speedy laser cutter, and the slices created by the 3D modeling software were cut from each respective foam sheet.

Half-Scale Dress Form Assembling. Each slice of foam was marked in number order before being assembled. Both models were supported using a tabletop stand with a wooden dowel. Due to the softness of the PU foam, it was fitted onto the dowel in two halves before they were adhered together. A felt cover was patterned and sewn to cover the irregular surface of the shoulders (Vuruskan and Ashdown, 2017). The PE foam model (#2) was assembled before it was fitted on the dowel, as the glue dried slower with the more porous material. The ½" PU foam dress form (#1) (Figure 1) exhibits a significant void between the bust and the belly, and it couldn't be filled without compromising the flexibility of the material. However, the sturdiness of the ¼" PE foam dress form (Figure 2) created a smoother and more accurate figure. To fill the gaps ('steps') between each sliced layer of the PE foam, a flexible clay was applied manually to replace the felt shoulder cover. Dress form covers were patterned via draping technique on each of the #1 and #2 half scale forms from modal jersey knit. Using ¼" knit elastic and pins around the bust and underneath the belly, the shapes of the dress forms were adjusted to emphasize accurate body shapes (Figure 3).

Figure 1. PU foam (#1)

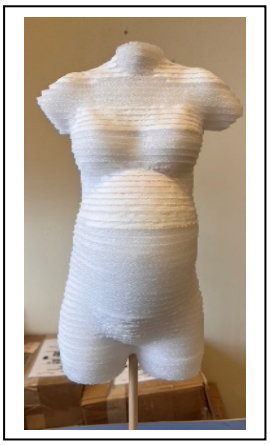

Figure 2. PE foam (#2)

Figure 3. PU foam (left) and PE foam (right) with cover

Assessment in CLO3D. There were three phases for assessing the shape and measurements of the dress forms #1 and # 2 to ensure the half-scale dress forms could be used accurately for draping to prodce a fitted garment. *Phase 1:* The authors compared measurements of two sets of digitized flat patterns (for body form knit stocking/sheath) that were draped on the #1 and #2 dress forms. The overall measurement of the two sets of flat patterns were similar, except all darts of the #1 dress form (in the very curvy shape areas) were smaller than the #2 form, specifically at bust darts, waist darts, and darts in the abdominal area. *Phase 2:* The two sets of digitized flat patterns were virtually fitted on the previously developed avatar in CLO3D. *Phase 3:* One new set of flat patterns were developed in CLO3D directly on the half-scale avatar and prototyped for fit assessment between the #1 and #2 fabricated dress forms.

Conclusion and Implementation. Two virtual fittings were conducted on the virtual avatar using the digitized flat pattern pieces that align with #1 and #2 forms (proper scaling of patterns was performed). Both of the virtual fittings did not show any tightness in any area. However, the #2 dress form produced a visually more fitted sheath stocking than the #1 form particularly in the bust and abdominal area. Therefore, assessments indicate that in this study, exploring a female pregnant body, in very curvy areas (i.e., bust and abdomen) the #1 dress form may produce a looser-fit draped product than the #2 dress form, suggesting that the #2 dress form provides a more accurate representation of collected (via 3D body scan) measurements. Authors suggest from this initial pilot these results are due to the materials (foam type and width + clay) and methods used in the half-scale dress form fabrication process. It is recommended that future research that utilizes custom half-scale forms use ¼" PE foam rather than ½" PU foam and flexible clay to smooth resulting 'steps' as part of the slicing and laser cutting process. These suggested materials also allow the designers to pin as needed for design ideation, through draping techniques, without compression or deformation of the fabricated form shape. Future studies are planned to trail this piloted process for multiple body shapes into a graduate-level apparel design course(s) in upcoming semesters.

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