Influenced by Microgravity: The Development of Half-Scale Body Forms for Intravehicular Activity (IVA) Suit Design

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Vurushan and Ashdown (2017) demonstrated how full body 3D scanning of active body poses can be used to develop "watertight" digital models and half-scale dress forms to facilitate design, pattern making and fit analyses. For this research project, Vurushan and Ashdown's method was modified to develop dress forms, for a graduate student's MS thesis project, focusing on Intravehicular Activity (IVA) apparel.

Using NASA's "Man-Systems Integration Standards," body position was identified for space travel (Figure 1). From the standard, the student created several cardstock goniometers to situate at the center of each major body joint (e.g., shoulder, elbow, hip, knee), of a male and female subject, so 3D scans could be captured. The goniometers insured that the subject's body reflected the NASA standard.

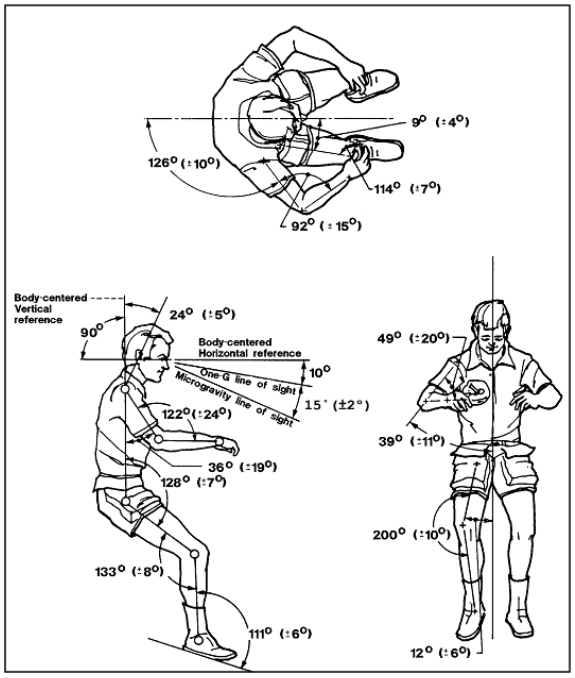
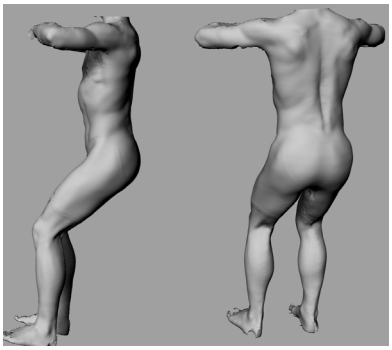


Figure 1: Neutral Body Posture (NASA, 2018)

3D body scans of the male and female subjects were taken with a Cyberware laser scanner. Scan files were exported as Obj files and surfaces were made "watertight" and smoothed using Rhino software. The files at 50% scale were sliced into 2mm sections using Fusion 360, and then LASER cut out of PE foam.

Foam parts were then matched, stacked and glued into shape. Dowels were situated inside each mannequin to keep it stable, so the student could interface and drape IVA product concepts.



3D body scans of male subject in neutral position

Sub-divided scan parts cut in PE foam

Assembled foam male and female mannequins

Figure 2: Microgravity mannequin development process.

The ability to create half-scale mannequins for products where the body is in a non-static, ergonomic or environmentally influenced position provides designers a better base for pattern development and styling. Several findings came out of this research. First, it is a complicated process to set-up the human subject in a neutral microgravity position for 3D scanning, as every major joint angle is affected. Having several goniometers handy allowed the researcher to set them ahead of time (to the NASA standard), therefore saving time of resetting one single unit. Secondly, it was found that using a thicker foam for cross-sections would not work with this type of dynamic posture, as it created a mannequin with too many surface "jumps," which would make it harder to drape upon. Because of this surface challenge, cross-sections were reduced to 2 mm, which then created hundreds of sections (Figure 2). With the current mannequins (Figure 2), knit covers could be added to help with surface consistency and to provide a stable pinning surface for product creation.

References:

NASA. (2018). Man-systems integration standards. Retrieved from: https://msis.jsc.nasa.gov/sections/section03.htm

Vuruskan, A. and Ashdown, S. P. (2017). *Modeling of half-scale human bodies in active body positions for apparel design and testing*, International Journal of Clothing Science and Technology, Vol. 29 Issue: 6, pp.807-821, https://doi.org/10.1108/IJCST-12-2016-0141