Gloveborne

Adriana Gorea and Casey Tyler
University of Delaware

Keywords: knitwear, 3D shape, natural dyeing, sustainability, modular design

Contextual review. After inventing the glove knitting machine in 1964, Masahiro Shima, the founder of SHIMA Seiki, stated: "*We can make a sweater by putting three fingers of a glove together*!!", and the knitwear industry did just that, started to create seamless garments by manipulating the glove template (Fig.1a) (Shima Seiki, n.d., p.1). The development of databases of standard 3D knitted garment shapes, pioneered through the WHOLEGARMENT© technology in 1995, has streamlined knitwear production, but also created a barrier between designers and the creative design process, reducing the opportunities for silhouette innovation that occurs when experimental engagement and draping of the material is involved (Motta & Dumitrescu, 2022; Gorea et al., 2021). In Masahiro Shima's words, *"The challenge we face now is in how to utilize computers to create human-ness*." (Shima Seiki, n.d., p.1).

Moreover, along with the adoption of advanced knitting technologies came an explosion of synthetic yarns that flooded the knitwear industry, as the filament fibers offer the finesse and durability required by the fast-knitting machinery. Yarns made of post-consumer recycled polyester (or polyethylene terephthalate- PET), such as Repreve®, are currently widely used for mass knitwear production, but the coloration process of these garments still uses disperse dyes that are problematic due to their toxicity and persistence in the environment (Che & Young, 2022). In recent decades, researchers have experimented using natural dyes on synthetic textile materials, but the color intensity and colorfastness results have been found to be limited (Harsito et al., 2021). However, several designers (Stella McCartney, Eva de Laat, etc.) found that blending wool yarn with PET yarn and dyeing the fabric with natural dyes offers subtle, soft, and elegant color patterns along with a sustainable path to achieving a designer fabric aesthetic, combining wool's luxurious texture and color retention with PET's durability for eco-conscious knitwear (PRWeb, 2021).

Therefore, the purpose of this project was to explore how the standard 3D knitted glove shape can be manipulated to create an innovative garment silhouette by elevating the digital design process using *humanized* tactile creative techniques, such as modular draping, natural dyeing and couture assembly. The research through practice approach was used, where the seamless 3D shape of a knitted glove served as the draping module, aiming to fill a knowledge gap as no studies were found to use such repeating module for creative design process (Chen & Lapolla, 2021).

Process, technique, and execution. Shima Seiki SW041N2 15gg knitting machine offers a glove template through its APEX 2.1 software with several customization parameters: finger shape and size, palm size, thumb shape and size, elasticized cuff width, etc. By draping 4 default- sized medium knitted gloves (made of greige Repreve ®polyester yarn) on a half-scale size 8 women dress form, a silhouette direction was

© 2025 The author(s). Published under a Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

initiated. An early version of the drape (Fig. 1b) shows that the default-sized glove was too small to drape around the back, therefore easy modifications to the template program were made, such as triple all finger lengths so they can interweave and flip, and double the width of the glove. The draping technique aimed at using the weaving of the fingers to connect the modules and minimize assembly by stitching. To gain guidance on silhouette development, visual inspiration for texture and color was collected by researching ancient natural dyes and plants.

Madder root is a traditional natural dye derived from the *Rubia tinctorum* plant, a climbing perennial with tiny yellowish star-shaped flowers. Besides the very long roots, which have been cultivated and processed for thousands of years for red dye, the madder plant also produces small black berries (Fig. 1c) (Yusuf et al., 2013). The design elements added by using madder root as inspiration were small black beads, textural star-like knit stitches, winding root-like bands of various widths, and ombre effect of orange/rusty color tones. To transfer the drape from half-scale to full scale, the number of stitches and rows knitted for the already enlarged glove module have been doubled, avoiding other shape manipulations or complicated programing. The edges were left open at the fingertips, so the fabric is slightly rolling, coordinating with the roll of the elasticized cuff edge. A very fine (19Ne size) greige 100% wool yarn was plied with the Repreve ® yarn. White nylon-covered spandex yarn was added to the glove cuffs. A textured lace- stitch in the front and tuck-stitch in the back pattern band resembling winding roots was placed along the fingers. This raised design has small yarn floats on the reverse pattern within a smooth jersey ground and was aimed at adding textural interest as well as reversibility to the folding fingers.

Four full-size gloves were knitted and draped on size 6 missy dress form. Several times during knitting the wool yarn broke and the gloves needed to be re-started, resulting in extra glove finger pieces. To vary the design module, 3 very small gloves were knitted with extra-long fingers, imitating the thinner roots of the madder plant. Commercial madder root powder dye was used along with alum pre-mordanting for 24 hours of all knitted pieces. To achieve an ombre effect, the fingertips were left in the dye bath an additional 12 hours then dipped in a vinegar solution. All pieces were then rinsed in cold water and hung dried. Draping was finished with small hand-tuck couture stitches along with black beads. For a sustainable near-zero waste approach, the extra fingers were draped without cutting the fabric and resulted in the hood piece. The small gloves with long fingers were attached on the shoulders to enforce the connection of the front and back. The tiny beads were threaded on thin black floral wire and twisted in fractal patterns, mimicking the branching patterns found in nature.

Cohesion and aesthetics. The concept of modular design has been creatively used in a manner that the glove shape is not identifiable. The contrasting linear elements guide the eye along the dress, pointing to the numerous textural details inspired by the madder plant, for a nomadic feel and an alien-like silhouette. The black beads add focal point through color contrast, and the up and down pieces give fluidity and volume to the bottom part of the dress. The density of design elements is balanced by the open areas around the waist between some of the lacing fingers, hinting at how the bottom two gloves were draped upwards. The elasticized cuffs of the gloves have been used for both their

© 2025 The author(s). Published under a Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

aesthetic as well as functionality of shaping the bottom of the dress as well as curling out under the arms. This design was built from the fiber/yarn up, and its visual impact is shaped by the body and motion, with surprising and delightful angles.

Design contribution. This work advances both the sustainability and innovation of apparel design using advanced knitting technologies, showcasing how synthetic fibers could be used without the toxic colorants. *Gloveborne* also stands as a teaching resource aiming to encourage new designers to engage with advanced knitting technologies without using complex programming, but by using traditional creative process tools (Motta & Dumitrescu, 2022). By blending old craft traditions with new knitting technologies through the modular design technique, this research builds upon the scholarship on advancing creative and sustainable employment of techniques in knitwear design (Chen & Lapolla, 2021; Gorea, 2025).

(a) (b) (c)

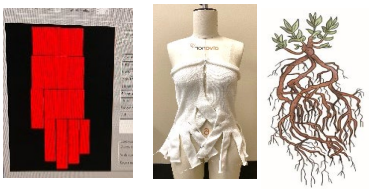

Fig. 1. (a) Apex software glove template, (b) initial half-scale drape, and (c) Madder plant (Dyeing Crafts, n.d.).

References

Che, J., & Yang, X. (2022). A recent (2009–2021) perspective on sustainable color and textile coloration using natural plant resources. *Heliyon, 8*(10).

Chen, C., & Lapolla, K. (2021). The exploration of the modular system in textile and apparel design. *Clothing and Textiles Research Journal*, *39*(1), 39-54.

Dyeing Crafts (n.d.). Retrieved from https://dyeing-crafts.co.uk/product/madder-rhizomes/

Gorea, A., Baytar, F., & Sanders, E. A. (2021). Challenges and design opportunities in prototyping seamless knitted apparel: a case study. *International Journal of Fashion Design, Technology and Education*, *14*(2), 127-138.

Harsito, C., Prabowo, A. R., Prasetyo, S. D., & Arifin, Z. (2021). Enhancement stability and color fastness of natural dye: A review. *Open Engineering*, *11*(1), 548-555.

Motta, M., & Dumitrescu, D. (2022). The role of teaching advanced technological knowledge to enhance experimental creativity in knit design. In *Human Factors for Apparel and Textile Engineering* (Vol. 32, pp. 1-8). AHFE International.

Ozdemir, M. B., & Karadag, R. (2023). Madder (Rubia tinctorum L.) as an economic factor under sustainability goals in the textile dyeing. *Journal of Natural Fibers, 20*(1), 2128968.

PRWeb. (2021, June 21). *Interview with Eva de Laat, Creative Director of Material Experience Center, on the future of the textile industry post-pandemic*. PRWeb. https://www.prweb.com/releases/interview-with-eva-de-laat-creative-director-of-material-experience-center-on-the-future-of-the-textile-industry-post-pandemic-877120963.html

© 2025 The author(s). Published under a Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Shima Seiki. (n.d.). *The Founder, Masahiro Shima*. Retrieved May 29, 2025, from https://www.shimaseiki.com/company/dna/founder/

Yusuf, M., Shahid, M., Khan, S. A., Khan, M. I., Islam, S. U., Mohammad, F., & Khan, M. A. (2013). Eco-dyeing of wool using aqueous extract of the roots of Indian madder (Rubia cordifolia) as natural dye. *Journal of Natural Fibers, 10*(1), 14-28

Gorea, A. (2025, January). Illusion Raindrops- A 4D Knitting Exploration. In *International Textile and Apparel Association Annual Conference Proceedings* (Vol. 81, No. 1). Iowa State University Digital Press.

© 2025 The author(s). Published under a Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

© 2025 The author(s). Published under a Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.