Title - Personal Bubble-Digitally Knitted Space for Bodies
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The purpose of this creative scholarship is to apply a working relationship between craft practice, material knowledge, and digital fluency to advance digital knit scholarship and use of this technology for innovative transformation of digital textile production, through the design of a shaped, 3D digitally knit vest. The vest design was inspired by the outcomes of numerous test swatches exploring volume, shaping, and tactility, leading to the development of a garment utilizing the shaping capabilities of the digital knitting machine and embedded pockets throughout, for use beyond carrying things to provide protection and insulation as well as the form of the final garment.

This is explored via knowledge through practice methodology (Bye, 2010) in the development of a vest utilizing the Stoll ADF-3 7.2 gauge digital knitting machine, the accompanying proprietary programming software Create+, and CAD apparel design software Clo 3d. Working through the craft and making process, we identify key characteristics and parallels between knit research and product development that embodies the relationship between digital technology and craft principles. Digital knit technology is a unique application of technology interacting with and directing the use of physical materials; as a result, it cannot be used in innovative ways without the direction of a skilled craftsperson. Previous applied scholarship focused on challenging the boundaries of the application of digital knitting through an interdisciplinary collaboration between apparel and architecture design, which, along with subsequent extensive research on the technology, materials, and both craft and industrial uses of the technology, led to this design process (Riewe Stevenson & Meakins, 2022).

While knitting production is mechanized and now digitized, the development and programming of the knit object remains a largely analog process relying on conceptual knowledge of the underlying craft methods. The process of programming requires a direct understanding of the material process of knitting yarns in a continuous, unbroken path. Different stitch actions, loop lengths, number of needles activated, and partial knitting are used to develop 3D shapes (Liu et al., 2021); this combined with the material characteristics of the yarn selected introduces extensive possibilities for exploration. This highlights the importance of all components of the process: knit design, technical program, and material characteristics. There exists a significant gap between soft goods knitwear designers, who often rely on cut and sew processes to design knitted goods, and technical programmers, who

Figure 1: Embedded Pocket test

Figure 2: Large Gauge Embedded Pocket Test

understand the technical process and structural capabilities of digital knitting, contributing to inefficiency and missed opportunities to advance the capabilities of this technology. (Gorea et al., 2021)

In the development of the knitted vest described here, the process began with trial-and-error testing of capabilities of the double-bed digital knitting machine. Exploring both embedded pockets (Figure 1 and Figure 2) and using a short row goring technique instead of darts to shape textiles, numerous samples with variations in fiber materials, machine gauge, as well as size and location of the pockets and shaped portions were produced. The digital file parameters were constantly updated and redesigned in response to the results of each test, yielding an immediate feedback loop from material concept to digital program to physical object and back again. This feedback and collection of samples and knit program files were then explored in application to a range of products. The silhouette was inspired by the volume added to the textile through the knit structure. A "bubble" shaped vest was designed in Clo 3d, with the curve of the 2D pattern translated into a digital knit pattern applicable to the gored shaping process used in the knit program to create 3D textile goods (Figure 3). The garment was developed in symmetric, mirrored pieces due to width limitations on the machine available to the researchers; these shapes were then imported into Create+ to develop the knit files, with information from the knit gauge swatch used to calculate size. The resulting knitted pieces directly reflects the knit exploration process, and along with the craft skill and technology fluency of the researchers, shows that "cloth persists as a record of the process;" and the physical knitted object embodies a continuous program and pattern process (Plant, 1998, p. 121) To complete the look, a polyester taffeta princess seam sheath dress with a bubble hem was cut and sewn. This creates a cohesive, contemporary look that is aesthetically expressive as well as protective of the body in both silhouette and feel (Figure 3).

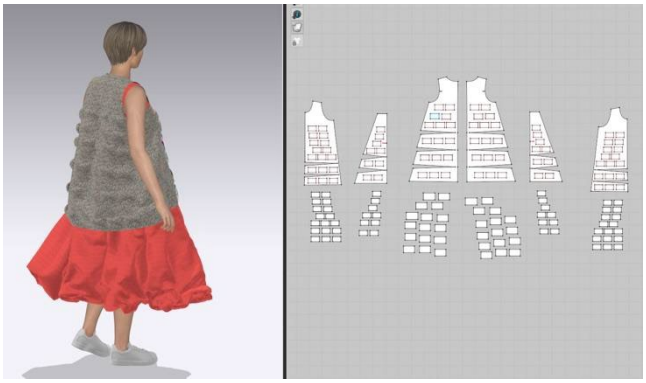

Figure 3: Clo 3D pattern to Knit Shape

Beginning the knit development process through pure experimentation and learning through testing, rather than beginning with a production outcome for a set product, allowed for a creatively robust and immediately reflective research process. The final product is the direct result of both the knowledge of body and space as well as an understanding of the knit process, which was used to construct a garment that, rather than rely on traditional ideas of flat pattern making, utilizes "inherent potential in conceptualizing techniques as thought processes and systems (Lehmann, 2012, p.155-156). When technology is solely focused on the solution of problems instead of including creative exploration, it becomes merely a tool with a means to an end (Parsons & Campbell, 2004, McCullough, 1996). This highlights the value of applying practice-based methodology to seek out innovative processes using "making as a way of generating design knowledge." (Loh, et al., 2016, p190) This allows the process to operate in a

responsive, networked system that can expand on discovery through an "open system, one that is networked, responsive, and expanding." (Vaughan, 2019, p 12) Digital knitting requires craft making to challenge and expand the possibilities for innovation and requires connecting digital notations and language with material craft, as the "manner in which fabric and the garment are produced reflects a way of thinking. The making begets the knowing." (Lehmann, 2012, p.157) Future explorations of digital knitting through this lens will expand this work to additional apparel applications and beyond.

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