Parametric Spreading Design for Knitted Floats and Stitch Pattern

Abstract: Background: This paper explores the integration of parametric design principles in textile pattern designs, focusing on the potential of computational tools to enhance creativity and innovation in the field of textiles. The study aims to address the question of how parametric design can be applied to generate intricate and dynamic patterns for textiles, opening up new avenues for personalized and responsive designs. Methods: The research employs Grasshopper in Rhino3D as a computational tool to develop parametric knitting patterns. By manipulating design parameters such as stitch placement, density, and scale, the study investigates the possibilities of creating visually appealing and customizable textile patterns. Results: The study demonstrates the successful integration of parametric design in generating complex and responsive textile patterns. It shows the interplay between digital design tools and the tactile craft of textiles, highlighting the fusion of technology and tradition. The use of computational tools offers designers greater control and flexibility, enabling exploration of a wide range of design possibilities. Conclusions: The integration of parametric design in textile pattern designs holds significant potential for enhancing creativity and innovation in various fields, including interior design, fashion, and textile art. The study emphasizes the transformative capacity of computational tools to advance the design process and produce intricate and dynamic patterns. This approach opens up opportunities for personalized and responsive designs, revolutionizing the way textiles are conceptualized and integrated into design.

Keywords: Knitting; Parametric Design; Pattern Design, Craft, Digital Design

1. Introduction

Textiles and technology have a rich history of influence and symbiosis. One notable connection lies in the relationship between early computers and Jacquard looms, which were instrumental in inspiring the development of computing systems. Ada Lovelace, a visionary mathematician, recognized the potential of Charles Babbage's Analytical Engine, a precursor to modern computers, and wrote extensively about its capabilities. Lovelace drew inspiration from the Jacquard loom, which utilized punch cards to control the weaving process, and envisioned the potential for computers to generate complex patterns and perform intricate calculations [1].

2. Materials and Methods

This project based research explores the design process and development of a knitted textile panel for a folding divider wall, that plays with parametric patterning as a way to create porosity and uniqueness in the design. The design process for the knitted panels involved Grasshopper in Rhino3D to generate the conceptual ideas for the intricate patterns that incorporate both solid and transparent elements. The goal was to establish a set of rules within Grasshopper to determine the relationships between stitches and floats, enabling a dynamic play with transparency in the final knit design.

To begin, a common grid spreading definition was employed in Grasshopper, manipulating a series of lines around attractor points. In Grasshopper a set of parallel lines are determined as the base. This could resemble the wales or vertical columns of stitches stacked in alignment. Attractor points were randomly scattered across this set of lines. The attractor points were used to create spreading in the lines. This is done by reversing the relationship of closest point and line. The lines were divided in to a set of points along the line which would then measure a distance between those points and the closest point. The inverted relationship would be that where the points on the line was closest to the point it would then actually move father away. And those points on the line which are farther would move very little. This creates a spreading effect. See Figure 1.

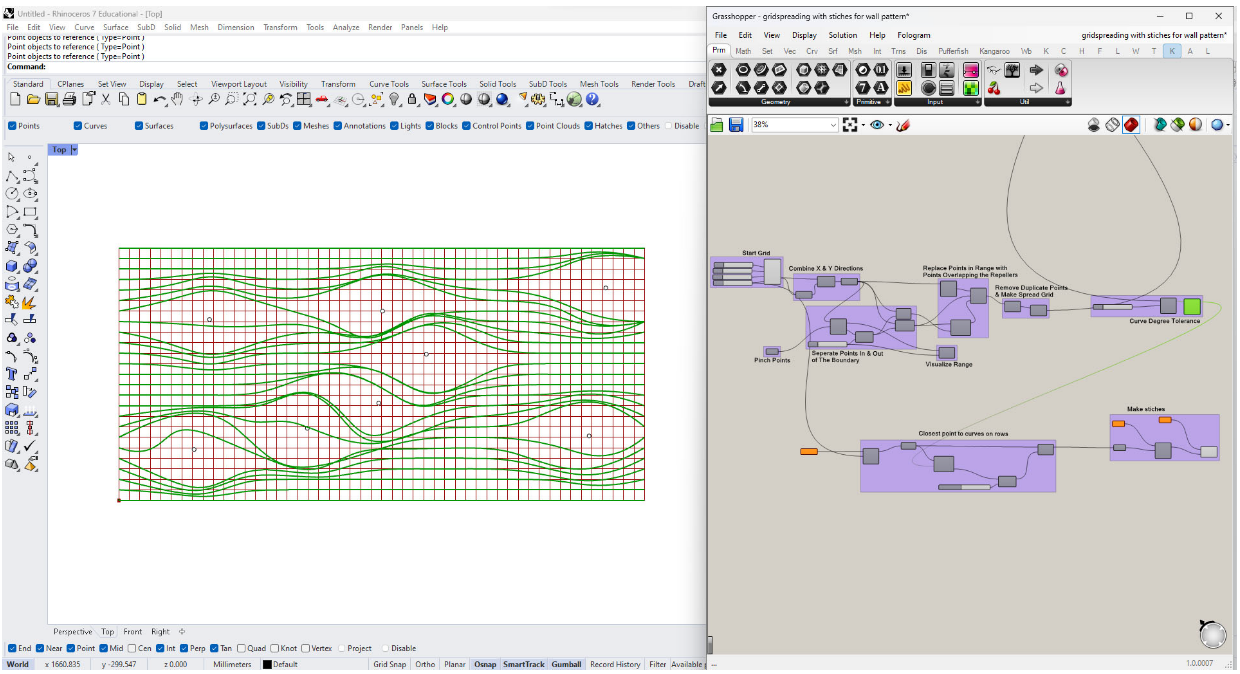

Figure 1. Grasshopper definition for grid spreading.

These lines then would represent the courses the knit. Which could overlay the stitch types of either float or stitch. See Figure 2.

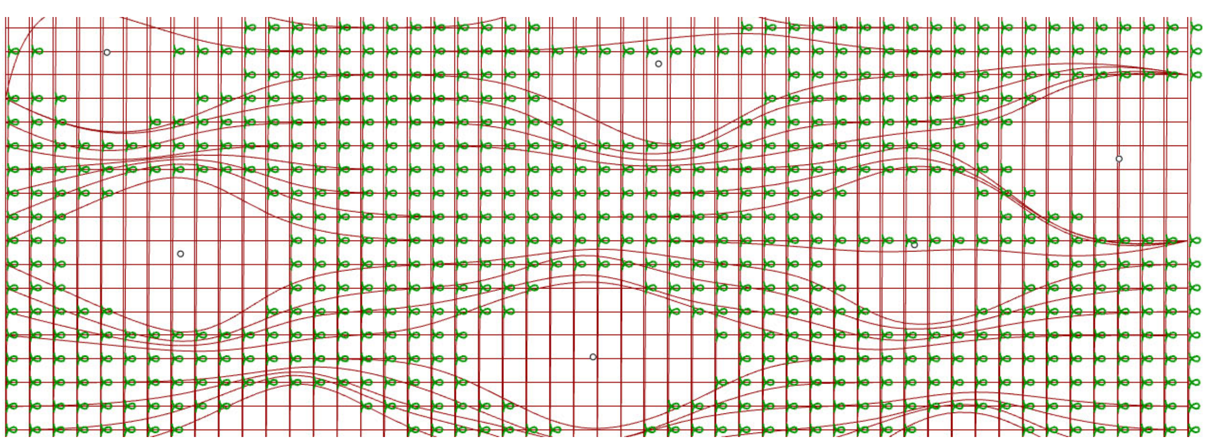

Figure 2. The overlay of stitch types over the spreading pattern in Grasshopper.

This allowed for iterative exploration helped establish the proportionality between the number of stitches and floats, revealing various possible pattern outcomes. This ultimately generated the conceptual idea of proportions of stitch to float ratio. By adjusting the number of attractor points to determine how much or how little spreading and transparency versus opacity was desired. See Figure 3.

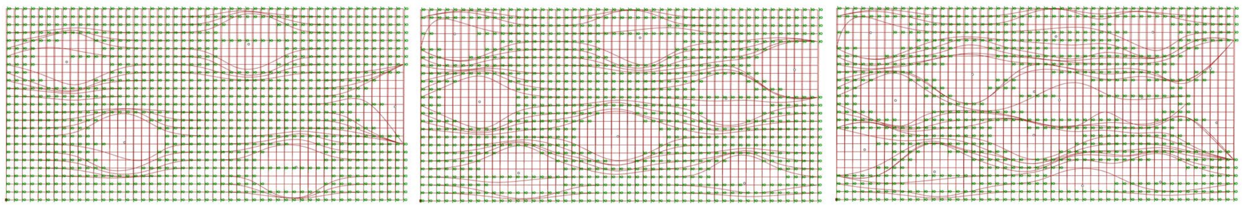

Figure 3. Variations from less to more spreading of stitches to float ratio.

To achieve the triangular panel shape, a technique known as narrowing was employed. This involved transferring stitches at the edge of the material every few rows, reducing the number of needles and narrowing the width. Starting with a full width of 108 stitches, the stitches at the edges were transferred to the neighboring needle every eight rows, resulting in a gradual reduction of width. By the end of the 336 rows of knitting, only eight stitches remained on the knitting bed to form the top point of the triangle panel. This provided easy bind off at the end of production.

In order to facilitate production speed, the parametric pattern design was further adjusted manually. Rather than adhering exactly to the computer generated design, which dictated changes in stitches and floats with each row, the design was modified to repeat the pattern every eight rows to create elongated shifts. This adaptation aimed to simplify the fabrication process, considering the movement of the knitting machine carriage and the manual manipulation of active stitches using a transfer tool. See Figure 5.

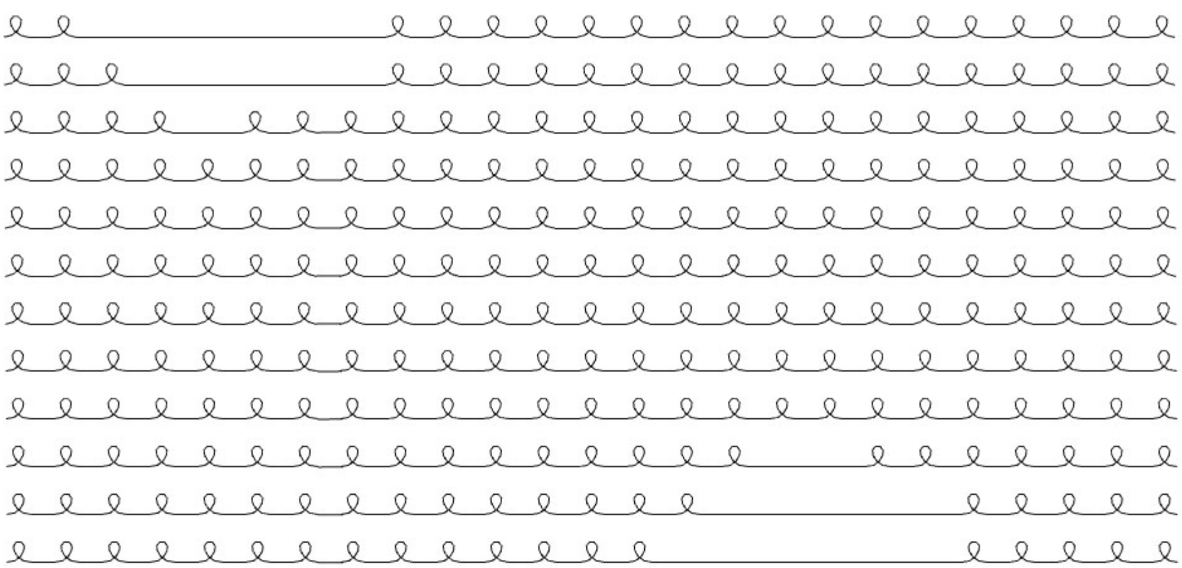

Figure 5. Sample of the final pattern design.

The knitting process itself was performed manually, requiring several hours for each panel. Since this involved a human craftsman following a printed pattern, mistakes and errors were inevitable, including counting errors, dropped stitches, or mistaken transfers. However, these imperfections were embraced as part of the craft, contributing to the uniqueness of each panel. As long as the craftsperson took the time to manually adjust the design to repair any errors and begin to make it match as much as possible to the original design patterns.

The detailed process of designing the knitted panels and the meticulous crafting involved in their creation highlight the integration of parametric design principles with traditional knitting techniques. This approach offers a new dimension to textile design, combining digital tools with manual skills to produce unique and visually striking design elements, using simple knitting techniques of stich and floats.

3. Results

The final dimensions of the knitted screen wall, measuring 2m (6.4ft) long by 1.8m (6ft) tall and 0.33m (13in) deep, proved to be successful in providing a visually engaging and lightweight architectural element. When collapsed, it was easily transportable and deployable. The lightweight nature of the knitted screen, allowed a single person to effortlessly carry and unfold it into an upright standing position, enhancing its practicality and versatility. See figure 6.

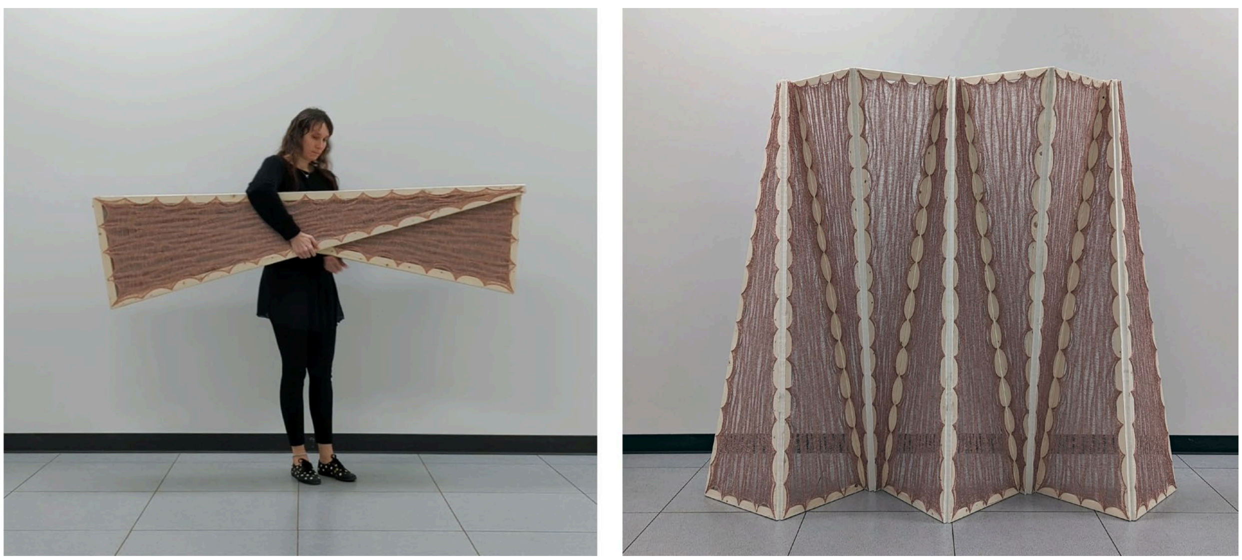

Figure 6. Final wall design.

The knit pattern particularly played the significant role in achieving the project's goals of screens and transparency. By leveraging the pattern design with Grasshopper in Rhino3D and applying parametric design principles, the pattern seamlessly transitioned solid and transparent areas, providing a play of light and shadow. The dynamic shifts in aperture and transparency created captivating patterns of light that added an artistic touch to the space.

The design of the knitted screen wall incorporated two layers of textile separated by the depth of the wood frame, which resulted in captivating visual effects of patterning and shadow play. As individuals move around the screen and light interacts with the layers, dynamic patterns emerge, resembling a moiré effect. The intentional difference in the density of the knit pattern between the two layers contributes to this captivating interplay of light and shadow. Additionally, as viewers walk around the screen, the layers shift in parallax, creating ever-changing movement and depth in the patterns, engaging the senses and offering a unique spatial experience. Furthermore, the use of two different yarn colors for the front and back layers adds an extra dimension to the design, as the colors interact and complement each other, accentuating the visual impact of the knitted patterns. See Figure 7.

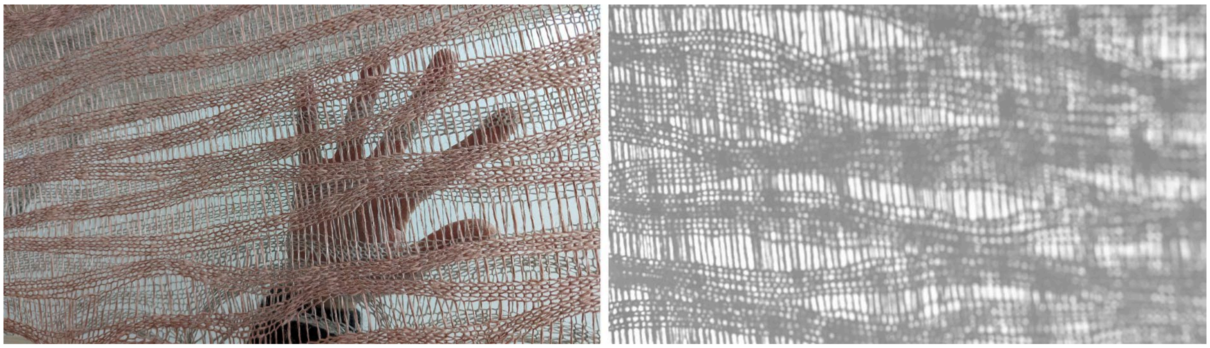

Figure 7. Final pattern details of shadows and texture.

The deliberate integration of these elements transforms the knitted screen into not just a static architectural element but a dynamic and engaging piece of art that plays with light, texture, and human perception.

However, during the fabrication process, some challenges arose. The textile dimensions were initially estimated to be tightly fit, leading to a scalloped effect at the edges where the material pulled. This is a result of calculating the tension of the sample knit swatches and scaling them to a larger proportion. Knit material does not have a linear relationship between smaller swatches and larger swatches, Thus scaling and more samples could have been made to test and make necessary adjustments to the pattern once the first panel was fabricated and issues was recognized. Although these were quite minor concerns and didn’t effect the overall result of the design.

Additionally, the attachment of the knitted material to the frame required further consideration. A smoother connection between the frame and knit material could enhance the overall aesthetics and emphasize the focus on the knit pattern. To avoid the scalloped edges perhaps not using point connections would be best to attach the textile to the frame.

Furthermore, during the fabrication process the importance of allowing more flexibility for the maker to manipulate the pattern or make adjustments on the fly during fabrication to achieve the desired result. This takes reflection on how you can design with digital tools but use those as a conceptual influence rather than as a fully resulted pattern to be followed to precise decisions.

4. Conclusion

The evaluation of the project's success was not merely based on its functional attributes but also on its contribution to the architectural and interior design discourse. The screen's ability to control light and visual connections, combined with its unique pattern, resonated with architectural theories of screens and transparency. The exploration of screens as "veils" and the blurring of boundaries between interior and exterior spaces were evident in the project's design.

Ultimately, this project demonstrated the potential of integrating knit material with parametric design in the context of architectural elements like screens. By embracing both traditional craft and digital fabrication methods, the project achieved a delicate balance between aesthetic appeal and functional performance. The use of patterned knit screens not only added an element of visual interest but also highlighted the significance of knitting as a form of "soft architecture," capable of shaping and redefining spatial experiences in contemporary design practices.Furthermore, the integration of digital design tools with handcrafted making highlights the value of human touch and craft in the creation of architectural elements. Richard Sennett's exploration of craft and making in "The Craftsman" (2009) emphasizes the importance of embracing errors and the maker's hand imprint on the final work [2]. This dynamic quality resonates with the concept of "architecture of error" as discussed by Francesca Hughes, embracing imperfections and unique outcomes in the fabrication process [3].

The success of this project demonstrates how parametric design in knitting patterns can offer architects and designers a powerful tool to push the boundaries of textile

based architectural elements. The seamless integration of computational design methodologies with traditional craft techniques expands the possibilities of architectural expression and spatial experience. As the project highlights the dynamic effects of screens and transparency, it sets the stage for further exploration and innovation in the intersection of textiles, architecture, and digital design. By embracing the unique capabilities of knitting patterns and their inherent connection to early computing history, architects can continue to push the boundaries of design and fabrication in the pursuit of novel and engaging spatial solutions.

References

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