Hot Spots – Blending Wearable Heat Technology in Fashionable Outerwear

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Wearable Technology, Heated, Tailoring

Contextual Review and Concept. Transformation of functional apparel and integration of technology are rapidly moving trends for our apparel industry with new developments offered daily. Design scholars are driving exploration in technology integration through process, design iterations, and end products. Hwang et al. (2018) noted a strong growth over a 12-year period in the number of design scholars who utilized technology in their design process, with over 50 percent of ITAA design scholars noting use in 2016. Additionally, with growth in maker's spaces on college campuses, interdisciplinary collaborations across colleges (Du Puis et al., 2020), and readily available hardware and electronics for consumer use, designers have prime opportunity to help shape future wearable technology apparel product for consumer markets. Understanding and meeting consumer demands for functional clothing poses technological challenges for the designer. Integrating varying levels of fashion to meet consumer demand for an enhanced design aesthetic is a secondary yet vital challenge for exploration. Thus, for this design collaboration, the objective was to introduce technology at multiple stages of iterative design (Bye, 2010) while incorporating wearable technology in high fashion, couture level, outerwear.

The project goal was to create a heated coat while meeting the psychological and social need for creative self-expression and status. Design inspiration came from an ongoing collection theme and color story utilizing trend research translated through flat sketching in Adobe Illustrator. Trends in high-end outerwear were reviewed and analyzed for appropriateness in the current project. The outerwear project incorporated technology at every step of the design process, from conceptualization and testing through development and execution.

Process, Technique, and Execution. Once the design was conceptualized, fabrics and materials were sourced or created. Two 100% wool plain weave outerwear fabrics were selected for use, one woven with boucle yarns. For circular embellishments, a majority of 100% wool felt appliques were used. Heating elements were purchased online, and the buttons were created for 3D print using a PLX filament. The *Hot Spots* patterns were created using Gerber Pattern Design Software (PDS). A first muslin was created, and adjustments to the body, hem circumference, and sleeve fit were made, partially for design aesthetics and torso heat management. A review of heated unit placement and an anthropometric and human physiological consultation assisted in finalizing the garment design and product placements (Dyball, 2024; Smith, 2024). As the multi-million dollar heated jacket market continues to grow with projections to reach 600 million by 2033 (Verghese, 2023), novel integration of warming technology presented new learning opportunities related to voltage requirements, waterproofing, interlinings, and best fabric choices. Heating pad selection for *Hot Spots* depended on body coverage, pad size, wiring requirements, and battery bank size. Decisions were made to utilize primary heating pads versus many small pads (hot spots) due to the wiring proliferation. The pads were ordered, a heat control panel, wiring, and USB connected battery bank were received. Wiring from the heating pads was channeled across the body to the side seam where it connected to the small control panel in side seam. The control panel on the heater had three settings: high, medium, and low. The outerwear was fused with weft interfacing. The wiring and heating pad were sewn to the cotton interlining which was inserted in a fully lined removable vest. The removable waterproof

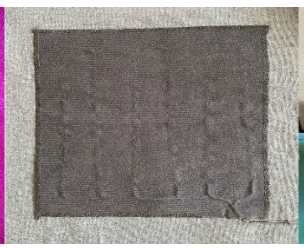
heating unit and vest can be laundered in a regular home washing machine, while the fully lined wool coat would be dry cleaned separately. The project sub-goal was technology integration with both 3D printing and laser cutting used in the coat. Best practice, as Bye (2010) notes, required several test iterations of both 3D-printed buttons and laser-cut hot spots. A Formslab 3D printer with PLX filament was used to create 3D printed buttons. Two variations were tested, one with no outer lip and one with a lip, for print quality and smooth terracing of the concave design. Color was adjusted by the addition of two coats of metal, wood, or plastic craft paint. Laser-cut hot spots were created in varying diameters (4 inches to 10 inches) in Illustrator and transferred to SVG format for the Epilog Laser cutter. Because self-extinguishing 100% wool felt was used, the laser seared and sealed the edges of the wool fabric, eliminating the need for turning and stitching. Additionally, laser cutting was more intricate and precise than hand cutting. Finally, leather button loops were thinned using a Cobra NP10 Skiving Machine and laser cut before sewing. The garment was constructed using industrial sewing equipment for topstitching and leather. Silk lining was used to finish the garment aesthetic.

Aesthetic Properties and Visual Impact. The varied textural qualities of the fabric selections and findings offer design interest without cluttering the overall aesthetic. The collar and cuffs offer color contrast while providing a visual outline for the coat. The size, color, placement, and application of the hot spots is intentional and designed for overall harmony and consistency in the design. Although other silhouettes were initially considered for the coat, a more minimal silhouette was chosen for the neutrality of the foundation layer and the consistency of the heating elements in contact with the body for warming impact. Finally, given that the design was an exploration for a high-end consumer, a carefully designed blend of sophistication in style and playful embellishment was pursued.

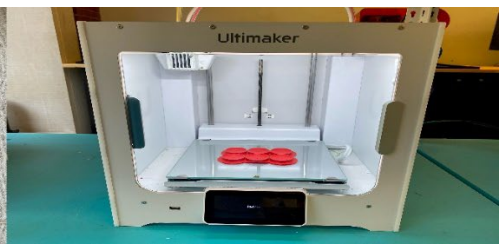
Cohesion. The monochromatic color palette of the coat and the hot spots unify the look and create a sophisticated yet fun design aesthetic. The circular theme is carried out from collar and applique to hemline sweep to add harmony and cohesion to the look. The added circular design of the jacket pockets both highlights and enhances the unity of the theme.

Design Contribution and Innovation. Integrating technology into *Hot Spots* outerwear allowed design scholars to expand their knowledge and skills, explore peripheral areas to design such as electronics, and comingle design and technology for both functional and aesthetic purposes in the designer market. The innovation of the design is noted in the variety of technology applications, not just the development of a heated coat. For instance, patternmaking, 3D visualization, 3D printing, laser cutting, electronics wiring, and skiving helped further the skill sets and enhanced creativity of the scholars. The design contribution includes planned skill integration into student curriculum, further exploration of expanded markets (and consumer demand) for creative heated coat design, and a focus on perfecting the wiring insertion and launderability of heated designs.

Heating Control Panel



Heating Pad and Wiring



3D Ultimaker Printer

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