A Visual Review of Computational Fashion Wearables: Design Directions through Sketching

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ABSTRACT

The present design challenges in computational fashion wearables (CFWs) increasingly focus on aesthetics and fashionability, as social acceptance often outweighs purely functional concerns. Since CFWs engage directly with social bodies, aesthetic considerations are becoming central in their adoption and cultural resonance. While existing literature extensively addresses technical aspects, aesthetic-focused research remains limited. This pictorial addresses that gap by examining CFW projects from academic contexts through a Visual Literature Review (VLR) and reflexive thematic analysis (RTA). Using freehand sketching as an analytical and generative tool, we annotated and synthesized a portfolio of prototypes, drawn from our previous literature review on CFWs, identifying three design directions—Augmented Expressions, Dialogic Expressions, and Ambiguous Expressions. These directions highlight how computational and fashion elements can be integrated to enhance expression, foster interaction, and embrace interpretive ambiguity. The findings offer actionable insights for designers and researchers, positioning aesthetics as a decisive factor in shaping future CFW innovation.

Authors Keywords

Fashion wearables; fashion illustration; aesthetics; fashionability.

CSSConcepts

• Human-centered computing-Human computer interaction (HCI)

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INTRODUCTION

Aesthetics and fashionability are integral to the design and development of Computational Fashion Wearables (CFW), and they act as key determinant of how technology is visually and functionally integrated into everyday life. CFWs, similar to conventional clothing, can be seen as our first social interface [6], communicating our personal and societal tendencies. They can establish an identity for the wearer by communicating the wearer's self-image and their membership to a social group [3]. As such, they need to be favorable, attractive, and aesthetically pleasing to the eye of the public to be socially and culturally accepted and commonly adopted [43]. Fashionability and aesthetics are closely interconnected, and recent CFWs design is growingly considering aesthetic aspects for crafting visually and sensorially appealing wearables, which can achieve fashion status [74].

Classical aesthetic and sociological theories offer valuable insights for understanding and enhancing fashionability in computational fashion wearables (CFWs). CFWs gain cultural legitimacy by echoing style norms while leaving room for personal expression, a dynamic explained through Simmel's dialectic of imitation and differentiation [78]. Likewise, the value of site-specific, interactive behaviors in preserving uniqueness despite technological reproducibility resonates with Benjamin's concept of the "aura" [8]. Dewey's account of aesthetic experience highlights not only visual form but also the embodied pleasures of comfort, tactility, and a "haptic grain," which foster lasting attachment between wearer and garment [26]. Bourdieu points to cultural capital, highlighting the need to work with subcultural gatekeepers for authentic adoption [11]. Likewise, a semiotic perspective positions garments as sign systems, where design elements—including interactive features—communicate meanings beyond function [7]. Together, these perspectives inform the design of CFWs that are socially meaningful, sensorially engaging, and semantically rich, allowing them to function not merely as technological artefacts but as culturally situated fashion statements.

In design discourse, aesthetics refers to the specific qualities of artifacts, typically infused with a positive value [30]. It is the study of beauty and taste, focusing on the principles and criteria that define what is visually and sensorially pleasing in a given cultural context. In design practice, It involves the careful consideration of elements such as form, color, texture, materiality and proportion to produce artifacts that are both functional and visually appealing. Aesthetics in CFWs encompasses both the immediate visual impression created by the shape and appearance of the designed item and the experiential qualities of its interaction facilitated by embedded smart technology [72], such as how LEDs pulse, how fabrics respond to touch, or how shapes shift over time. These behaviors can be conceived as aesthetic signs, conveying moods, narratives, or social affiliations. Drawing on Barthes' [74] view of fashion as a sign system, such behaviors move from denotation (function) to connotation (meaning) through codes of silhouette, material, and movement. In this sense, firmware, data mappings, and behavioral rules constitute an additional layer of "coded-clothing," offering a stylistic vocabulary which influences the legibility and adoption of the wearable.

In discussing the aesthetics of interactive design, scholars [21], [67], [62], [49] distinguish between analytical aesthetics, which is concerned with how an artifact looks, feels, and its formal qualities, and pragmatic aesthetics, which emphasizes the lived experience that arises through the interplay between user, context, culture, history, and engaging all sensory and intellectual faculties. Likewise, Folkmann [30] further identifies design aesthetics as the study of the sensual, conceptual, and contextual dimensions, which respectively involves understanding how design elements like form, color, texture, and material contribute to the sensory experience, how design communicates ideas and narratives, and how the broader cultural, social, and environmental contexts influence the perception and significance of design.

The aesthetics of wearable products create the first impression that visually connects with consumers and significantly impact consumers' purchasing decisions. It is a vital and determining factor in the acceptance and adoption of CFWs by the consumers. [88], [23], [50], [71] show that design aesthetics significantly influence the perceived value of products, highlighting that aesthetics are as equally important as functionality for consumers when making purchase decisions. While prior research [34], [17], [41] has frequently underscored the significant role of aesthetics in wearable adoption, much of the human–computer interaction literature [60], [75], [79] continues to prioritise technical aspects, with the aesthetic and fashionable dimensions of CFWs remaining underexplored [28], [48], [58], [87], [89], [93]. This gap is particularly challenging in an interdisciplinary field like CFW, where the integration of fashion expertise is essential. Consequently teams may always include expertise in fashion. To address this, there is a pressing need for studies that analyze existing work to identify strategies for achieving fashionability and to generate actionable design knowledge that guides the creation of aesthetically and culturally compelling CFWs [17], [69], [89].

To respond to this need, we conducted a Visual Literature Review (VLR) presented in pictorial form—an approach particularly suited to foregrounding the visual and material aesthetics of CFWs. Drawing on a previous comprehensive review of 82 CFW studies [41], we identified selected 18 academic works in which achieving fashionable aesthetics was one of the core goals.

These works produced wearable prototypes where aesthetic considerations were addressed alongside functionality. We engaged with these works through freehand sketching, allowing us to visually explore, reinterpret, and extend their ideas. Sketching, combined with a pictorial approach, has long been recognized in Human–Computer Interaction (HCI) as a method for ideation, abstraction, and communicating complex concepts [49], [67], [83], [84]. This process was accompanied with Reflexive Thematic Analysis (RTA) to identify patterns,

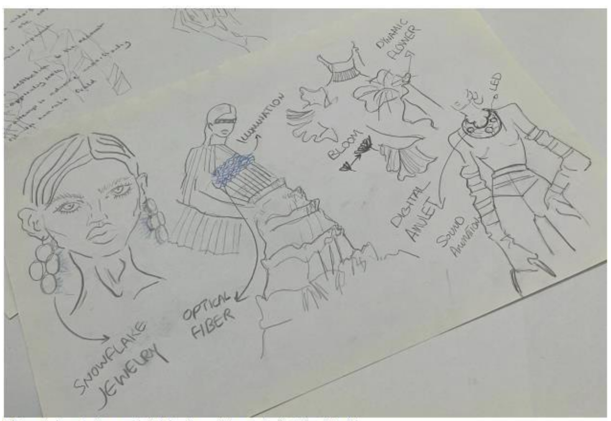


Figure 1: A pages from a sketch book used for producing this pictorial

develop conceptual insights, and formulate design directions that articulate the aesthetic potentials of CFWs.

Our study makes three main contributions. First, we present a curated, sketch-enhanced catalogue of academic CFW projects where aesthetics was an explicit design focus. Second, we propose actionable design directions to guide researchers and practitioners in integrating fashionability into wearable technologies. Third, we contribute methodologically by integrating visual literature review (VLR) and reflexive thematic analysis (RTA)—a combination not yet documented in wearable or fashion-tech research. While prior studies have applied visual reviews [40] or thematic analysis [85] independently, our approach unites them to capture both aesthetic form (via sketch-based abstraction) and conceptual depth (via interpretive coding). This fusion is especially valuable for computational fashion wearables, where form, materiality, and interaction aesthetics are inseparable from meaning-making, marking a methodological innovation for studying fashionability and social expression.

The paper is organized into three sections: (1) a presentation of selected prototypes through annotated sketches, reviewing how each addressed aesthetics; (2) an analysis of these works through RTA to identify potential future design directions; and (3) a discussion situating these directions within theoretical, methodological, and practical contexts.

METHOD

We carried out a Visual Literature Review (VLR) presented in pictorial form, an approach well-suited to foregrounding visual/material aesthetics in computational fashion wearables (CFWs). Building on a prior comprehensive review of 82 CFW studies [41], we selected 18 studies explicitly situated in the aesthetics category. Inclusion was determined by the authors' (a) explicit acknowledgement of aesthetics/ fashionability as a goal, or (b) consistent use of terms indicating aesthetic attention (e.g., aesthetic elements/effects, aesthetically pleasing/appealing, visual attributes, fashionable purposes/reasons, aesthetic customization, material aesthetics, fashionability, style). The 18 projects extend across apparel, accessories, and textiles with embedded, dynamic, and interactive technologies.

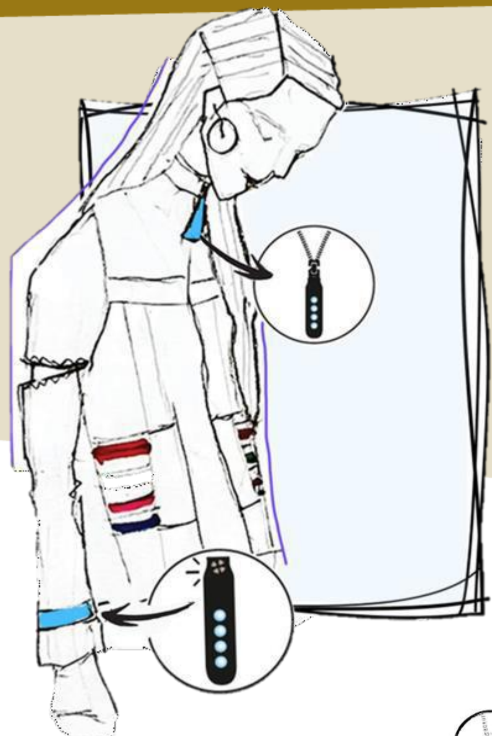
In phase one, we used freehand sketching to engage the corpus as design material. Sketching is a well-established technique for communicating, exploring, and abstracting ideas; it highlights salient features, simplifies complexity, and supports visual dialogue [55], [19], [73]. In HCI/UX, sketching is recommended for creativity, ideation, analysis of visual properties, and communicating with the audience [73], [54], [19]; it also aligns with designerly research practices that treat drawings as investigator-generated re-representations for reflection and synthesis [15], [36]. We used sketching as both an analytic and generative method. Redrawing prototypes to highlight silhouettes, proportions, and interactional cues and accentuate kinetic and material qualities aligns with established visual analysis practices in design and HCI [15], [32], [56].

Building on this, we extended the work into speculative concept sketches, which helped us bring the themes from Reflexive Thematic Analysis to life. These sketches acted as visual probes, making abstract ideas more tangible and opening space for imagining future directions in CFWs. Our team (fashion-tech and interaction designers) studied each paper's photos and, when available, videos, then produced fashion-style sketches to (1) capture form, silhouette, detailing, and interactional cues and (2) surface aesthetic strategies less legible in text-only accounts. In this way, sketching helped us move beyond description toward generating new conceptual directions for CFWs, defined here as body-worn artefacts enhanced technologically and aesthetically.

In phase two, we applied Reflexive Thematic Analysis (RTA) [14] to the study texts and our sketches. RTA supports iterative, interpretive coding and theme development grounded in researcher reflexivity [14]. Our procedure is as follows: 1. The first author, a fashion-tech designer, immersed herself in each study by reading closely, reviewing media, and writing reflective notes to capture early impressions, 2. She sketched each project to record form, interaction, and detail, creating a comparable visual record, 3. Beyond documentation, she produced speculative extensions inspired by artefacts, materials, and techniques, exploring new affordances and aesthetic possibilities, 4. The sketches and study materials were collaboratively discussed in multiple sessions with the third and fourth authors. We generated codes from both (a) the published data and (b) our sketch-based re-representations, distinguishing existing vs. newly developed codes, 5. We iteratively grouped and related codes across visual/material evidence (sketches) and textual accounts to construct overarching themes, 6. We compared patterns across the corpus and sketches, gradually shaping them into three design macro-themes. 7. We defined, analyzed, and named the final directions: Augmented Expressions, Dialogic Expressions, and Ambiguous Expressions, linking each to actionable design tactics and philosophical grounding.

Sketching served as focused lenses. Redrawing prototypes clarified silhouettes, proportions, detailing, and interaction cues often lost in photos. They enabled side-by-side comparison at a common scale; and allowed us to hypothesize missing aspects—such as kinetic sequences or material changes—based on the papers' descriptions. This form of designerly re-representation complements, rather than replaces, original imagery and aligns with visual analysis practices in design/HCI (e.g., visual analysis by [82], annotated portfolios and intermediate-level knowledge by [32], [56]. This VLR yields: (1) a curated, sketch-enhanced catalogue of the 18 academic CFW studies focused on aesthetics; (2) three design directions that synthesize aesthetic strategies as actionable guidance; and a methodological innovation by integrating visual literature review (VLR) and reflexive thematic analysis (RTA). The remainder of the paper presents the annotated catalogue, elaborates the three directions with examples, and discusses implications for research and practice.

ACCESSORIES/ JEWELRY



Cuffs & Zipper Slider [45]

Interactive modular strapped cuffs and zipper slider

Description: The modular "Cuffs & Zipper Slider" by Kim et al. [45] embodies visible light communication (VLC) technology. The cuffs' adjustable straps and embedded LED lights and the zipper sliders' discrete LED indicators provide interactive visual feedback

Fashion aspects: Modular cuffs and zipper sliders embody a minimalist approach focused on simplicity, versatility, and functionality [65], [1]. Their customizable design allows for various styling options, blending seamlessly with Conventional fashion. They merge visible light communication with sleek, contemporary aesthetics, offering discreet technological integration. Wearers valued their comfort, tactile quality, and sensorial appeal, aligning with research on material engagement and analytical aesthetics [45].

Hooze [94]

A kinetic fashion accessory for the shoulder

Description: "Hooze" by Zdziarska et al. [94] is a kinetic fashion accessory designed for tactile interaction and playful engagement. Physically, Hooze comprises flexible, responsive fabrics embedded with shape-memory alloys that enable movement and dynamic transformation when touched.

Fashion aspects: Hooze is stylishly minimalistic, which combines organic, fluid shapes with fashionable textiles, ensuring visual appeal and contemporary fashion relevance. The designers highlight wearing enjoyment of the playful and engaging interactions, emphasizing that fashionability is enhanced by tactile, kinetic experiences rather than purely visual design. The felt qualities, such as the softness, flexibility, and sensory responsiveness can significantly boost wearer satisfaction, while visual elegance, seamless form, and the artifact's interactive and dynamic movements further enhance its overall aesthetic and sensorial appeal.

Dynamic floral clothing accessory [68]

Dynamic flowers which sense signals from the surrounding and respond by blooming, swaying, or tracking light

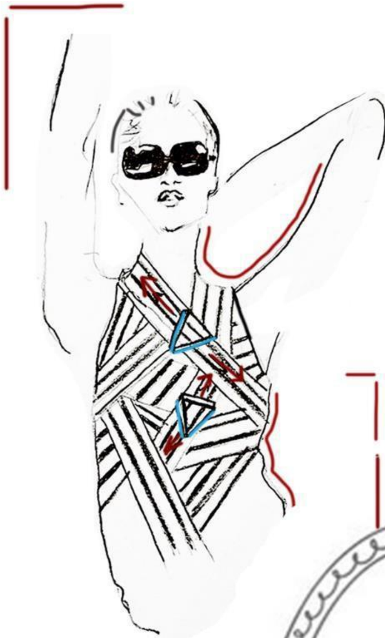
Description: Dynamic floral clothing accessory by Pan and Pan [68] incorporates shape-memory alloys (SMAs) and responsive textiles, which enable movement and shape-shifting capabilities in response to environmental stimuli, producing dynamic visual effects like blooming flowers and swaying branches.

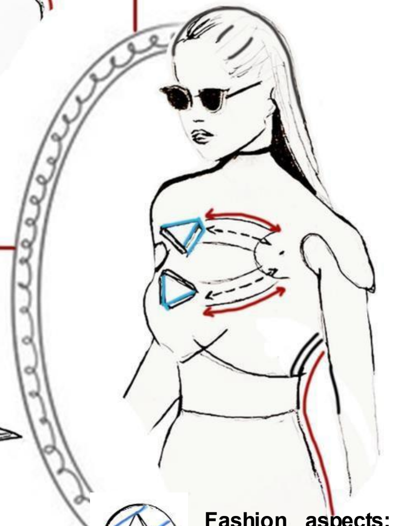
Fashion aspects: Dynamic floral accessory maintains traditional floral elegance, offering a vibrant yet visually harmonious appearance allow for both contemporary and vintage styles [29]. Felt qualities, such as texture, softness, and visual elegance, can significantly contribute to wearer's satisfaction and acceptance. Nature-inspired accessories with floral motifs are said to enhance aesthetic appeal and create dynamic and emotionally resonant pieces [42] by evoking symbolic meanings and nostalgic feelings and fostering a connection to nature.

Kino [44]

a kinetic accessoryand a minimalistic on-body robot in the formof a broochwhich shifts into anecklace

Description: Kino by Kao et al. [44] includes mechanical actuators and sensors embedded within flexible, soft materials to enable responsive movements and tactile feedback. The designers utilized motors and magnetic wheels as well as custom circuit to design a robotic brooch, which moves and changes from a simple brooch into a necklace.





Fashion aspects: The design of Kino showcases simple, geometric shapes that align with the minimalist tenet [18] of clean lines and uncluttered aesthetics. Kino's customizability and its abilities to morph and change shape provide dynamic visual effects and allow for the wearer's needs and style preferences. The careful balance between visual elegance, interactive responsiveness, and perceived sensory quality, provide interactive designs with visual and tactile integration enhances user acceptance, enjoyment, and perceived fashionability. And the gentle and discreet movements and tactile qualities of the wearables, underscoring the importance of material softness, flexibility and comfort, heighten awareness and positive sensory experiences in the wearer.

Mirror-Mirror [20]

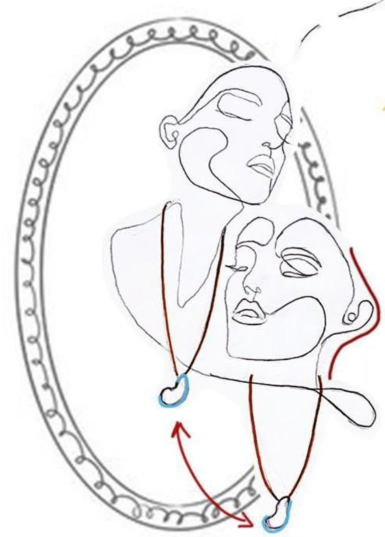
Anamulet pendant

Description: Mirror- Mirror is a concept accessory with a RFID tag, designed to help women focus on positive moments during the day. It involves an amulet pendant that the wearer touches when they experience a positive moment. Later this amulet reminds them of those moments

Connect [20]

A set of necklaces

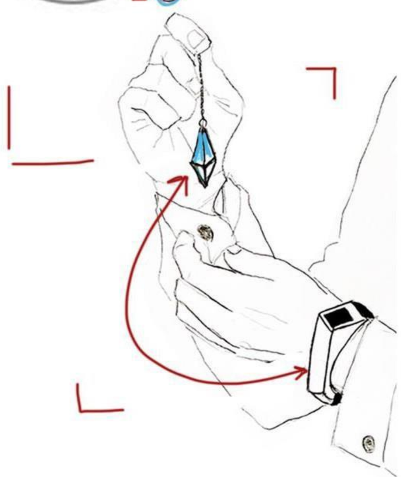
Description: Connect is a set of two identical necklaces which make a hug shape when they meet. It contains a magnetic sensor and an LED. When the friends meet in person, the necklaces get "charged." When at home, the wearer sets the necklace on its box, which emits light that slowly fades depending on how long it's been since the friends last saw each other.



Trace and Fibo [20]

Awearable compass-like pointer and a bracelet

Description: Trace is a wearable jewelry device featuring a GPS unit and vibration motor, designed to retrace a loved one's journey. Fibo is a pregnancy bracelet with a vibration motor, allowing the father to experience the baby's movements in real time through a servo motor synchronized with a fetal monitoring patch.



Fashion aspects: The wearable jewelry (Mirror-Mirror, Connect, and Trace and Fibo) by Carpenter and Overholt [20] blend sleek minimalism [18] with vintage-inspired elements, creating timeless pieces that appeal to both modern and classic tastes. The designs' Geometric patterns [57], streamlined shapes, symmetry, and harmony make them visually striking and desirable. The artifacts showcase contemporary elegance, leveraging minimalist designs with intricate detailing to maintain fashionability while supporting interactive features. The seamless interaction integrated into the jewelry preserves traditional fashion appeal and enhance emotional connectivity and interpersonal interactions. The felt qualities of these artifacts, including comfort, refined textures, and material quality, significantly influenced wearers' acceptance and overall sensory satisfaction.

Snowflakes Jewelry [17, 39]

Smart jewelry pieces such as IlluminEar (a stone like ornament worn on ears) and PubliNeck (an interactive pendant which receives notifications)

Description: "Snowflakes" by İnsel et al. [17], [39] is a modular prototyping tool aimed at rapidly designing smart wearables. The study employed 3D- printed pieces and hexagonal modules to create a number of interactive and playful jewelry pieces such as IlluminEar and PubliNeck. IlluminEar has multiple stone-like ornaments and when the wearer moves their head, the ornaments react to the movement both by swinging and changing color. PubliNeck was an interactive pendant for receiving notifications and exploring the public and private nature of feedback of interactive jewelry as well as their form factors.

Fashion aspects: The modular pieces feature sleek, minimalist designs that are easily combined, allowing for customizable, visually coherent, and fashionably interactive items and enhances the aesthetic flexibility [2], [62] of the pieces. That also allows the wearers to mix and match different modules to create looks that can reflect their personal style. Attending to the form factor (applying 3D geometric shapes) and ergonomic designs not only ensures that the jewelry is stylish but comfortable to wear. The qualities, such as the smooth texture, lightweight nature, and ease of assembly, can significantly enhance the sensory and tactile user experience. In addition, the interactive modalities such as light, vibration and sound create further visual appeal.

The Digital Amulet Necklace [80]

A smart necklace, or collar

Description: "Digital Amulet: Smart Necklace" by Sorensen and Thummanapalli [80] introduces a technologically interactive necklace designed as a digital charm. The necklace integrates compact electronic components such as sensors, LEDs, and microcontrollers and employs wireless and multimedia computing, acting as an agent of cross-cultural communication

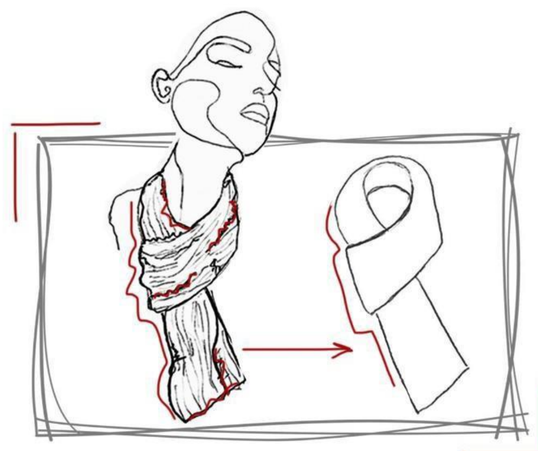
Fashion aspects: The elegant designs and patterns on the amulet seem to be inspired by ancient Egyptian symbols such as the Eye of Horus, symbolizing protection, health, and restoration. Its vibrant colors and intricate design are also reminiscent of traditional South Asian jewelry. The cultural motifs in the Amulet both serves as a meaningful accessory that enhances its significance and connects the wearer to rich historical and cultural traditions [52]. The designers' attempt on seamless technology integration, materials and form, and meticulous attention to details created a unique, functional, and visually appealing design. The necklace's felt qualities including material texture, weight, and tactile comfort, can positively impact user perception and acceptance.

Scarfy [90]

An interactive scarf activated through tying and knots

Description: "Scarfy" by Von Radziewsky, Krüger, and Löchtefeld [90] is a self-actuated and responsive scarf that uses embedded vibration motors, shape memory alloys and sensors to autonomously adjust its shape in response to environmental inputs, and let the transfer of information for notification.

Fashion aspects: The fashion item is a simple knitted scarf; however, the way of tying and the shape changing interaction introduces a novel stylish mode which is dynamic. Scarfy maintains a sleek, contemporary design, utilizing soft, visually appealing fabrics to ensure it is both fashionable and comfortable. Felt qualities," such as softness, flexibility, and tactile responsiveness, significantly contributed to wearer comfort and satisfaction. The dynamic quality can customize to suit individual preferences producing a personalized fashion experience [93].

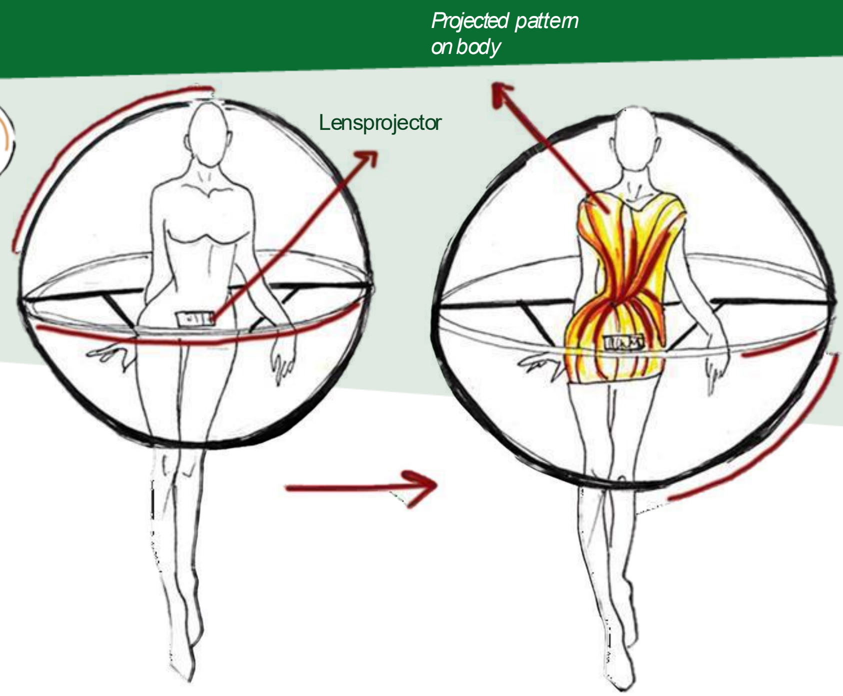


Live Scape BLOOM [60]

Embellished robotic flowers

Description: "Live: scape Bloom" by McMillan [60] is an IoT connected dress featuring interactive garments integrated with embedded sensors, actuators, and IoT connectivity. Embellished robotic flowers respond to real-time meteorological data flows to imitate living and breathing organisms.

Fashion aspects: Live: Scape Bloom prioritizes organic forms and visually captivating floral motifs, seamlessly blending advanced technological features with fashionable elegance. The felt qualities of the garments, such as soft textures and dynamic visual transformations, significantly enhance wearer satisfaction. Floral patterns produce a vibrant and feminine touch, and their classic elegance and timeless charm, as well as customizability and versatility make them suitable for both modern and vintage looks [29].



Queen's New Clothes [10]

A computing wearable costume

Description: The Queen's New Clothes" by Bian, Yao, and Hirsch [10] is an interactive wearable fashion costume, inspired by the Danish tale "Emperor's New Clothes" and Lady Gaga's Orbit dress, featuring three elliptical, interwoven orbits. The 'garment' employs embedded heating elements and a PIC microcontroller to trigger active illumination sources.

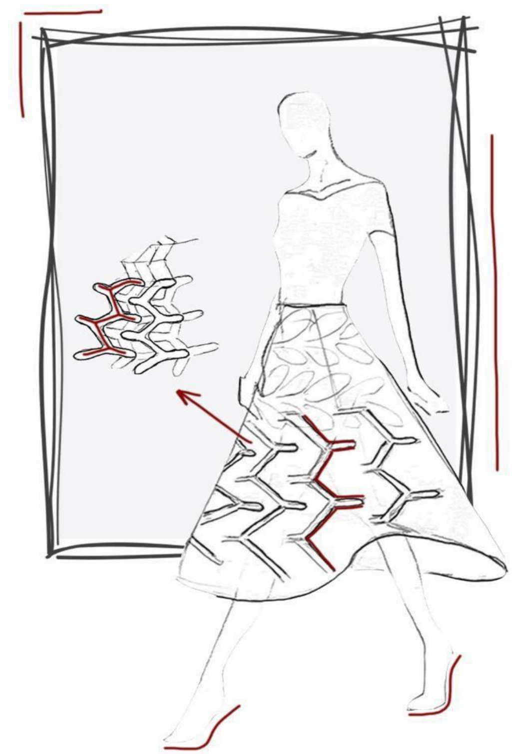
Fashion aspects: The wearable explores fashion's dual status in both the physical and digital worlds, with patterns changing based on time and location. The costume's ability to appear plain to the naked eye but reveal colorful, changing patterns in photos adds a layer of surprise and visual interest. This duality enhances its aesthetic value and makes it a conversation piece. Aesthetically, the garments present striking visual transformations, enhancing their fashionability through dramatic but harmonious design transitions. While the costume is visually striking, its practicality and wearability for everyday use might be limited. The focus on aesthetics and technology might overshadow considerations for comfort and ease of movement.

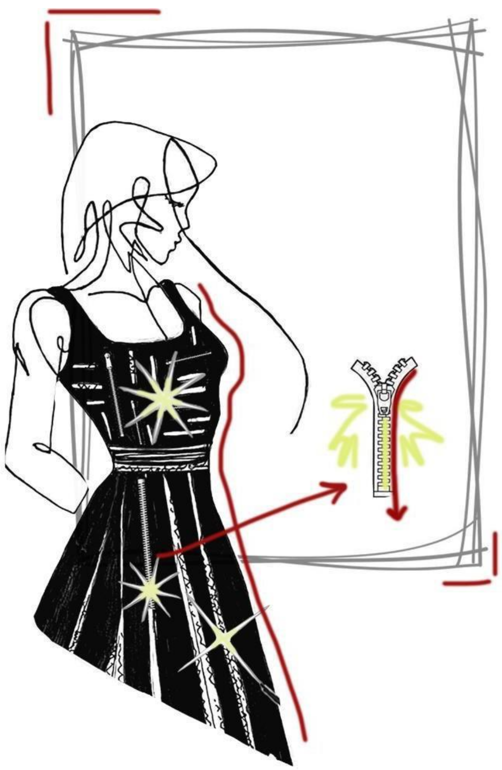
Awakened Apparel [70]

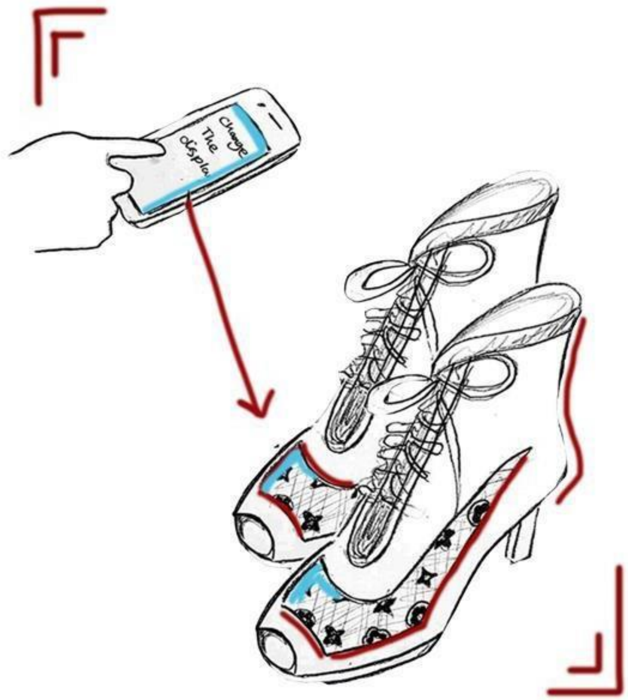
A shape-changing skirt

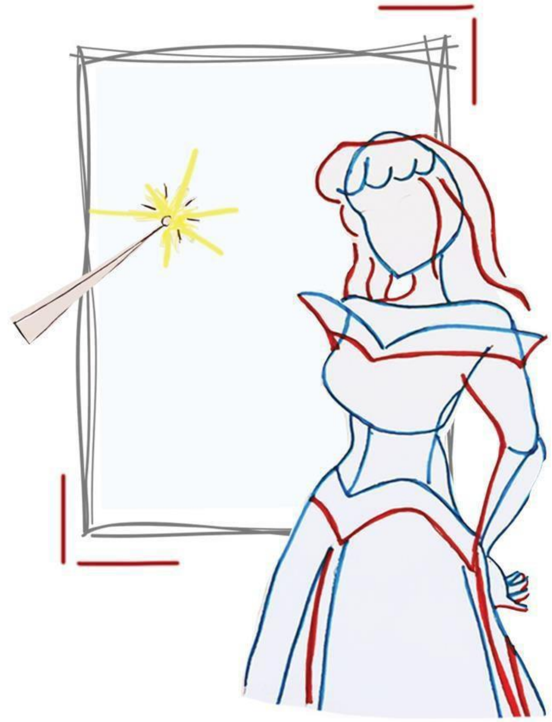
Description: The "Awakened Apparel" by Perovich, Mothersill, and Farah [70] explores the integration of soft robotics into fashion. The garment uses pneumatically driven soft actuators (actuated origami) that shift shape in response to user input or environmental stimuli.

Fashion aspects: Fusing pneumatics, origami patterns, and folding in garment design created aesthetically and tactilely pleasing dimensions and shape-changing mechanisms, emphasizing silhouette transformation and kinetic beauty. Geometric origami folds, as seen in Issey Miyake's works, offer a unique blend of aesthetic appeal and structural innovation, adding texture and dimension to garments [35]. These folds also create dynamic movement, as demonstrated in Jule Waibel's designs, and contribute to minimalist aesthetics and enhanced functionality [64]. The wearable includes lightweight, flexible textiles supporting fluid motion and ensuring both comfort and fashion appeal.









Lovely Rita [38]

Aninteractive dresswith zipper module

Description: "Lovely Rita" by Hye and Achituv [38] is made from two sets of Zippers that are controlled by an Arduino-mega microcontroller. The zippers' opening and closing alter the look of the dress. It integrates sensors, microcontrollers, and LED systems within a soft textile framework and responds to user interaction through illumination.

Fashion aspects: Zippers are a style element, and their dual functionality here not only adds a unique aesthetic but also allows for dynamic interaction with the garment. The concept of modularity, inspired by Lev Manovich's principles, provides the wearer with a high degree of customization and personal expression. The visual effect of light emitting from the zippers adds a striking and futuristic aesthetic to the dress [24].

Dynamic high heeled shoes [61]

Smart platform shoes

Description: Dynamic high heeled shoes by Mphepö, et al. [61] presents a prototype of a high-heel shoe with an electronic-paper display. This display can change colors and patterns to match the user's outfit, controlled via a smartphone app.

Fashion aspects: High heels enhance wearer's attractiveness by increasing lumbar curvature [53] and make the wearer more stylish. Augmenting them with technology to possess various flexible displays can further contribute to their attractiveness, customizability and style. However, high-heeled shoes are often criticized for their lack of comfort and adding electronic components should not exacerbate this issue.

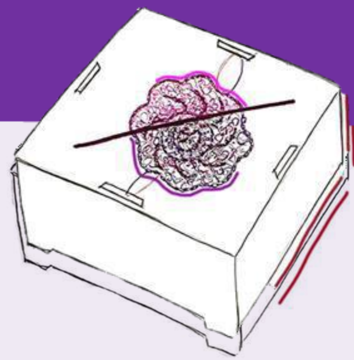
Sleeping beauty [9]

A controllable, color changingdynamiccostume

Description: This work by Berglund, et al. [9] were inspired by the Disney classic 'Sleeping Beauty'. The costume features addressable multi-color NeoPixel LEDs that change the dress's surface color based on input from two wand controllers.

Fashion aspects: The dynamic feature of the dress allows for real-time color changes, enhancing the interactive and visual appeal. The playful, immersive experience aligns with fashion trends emphasizing interactivity and user participation. It also adds a magical, visually striking element, making it a standout piece [41].

TEXTILE

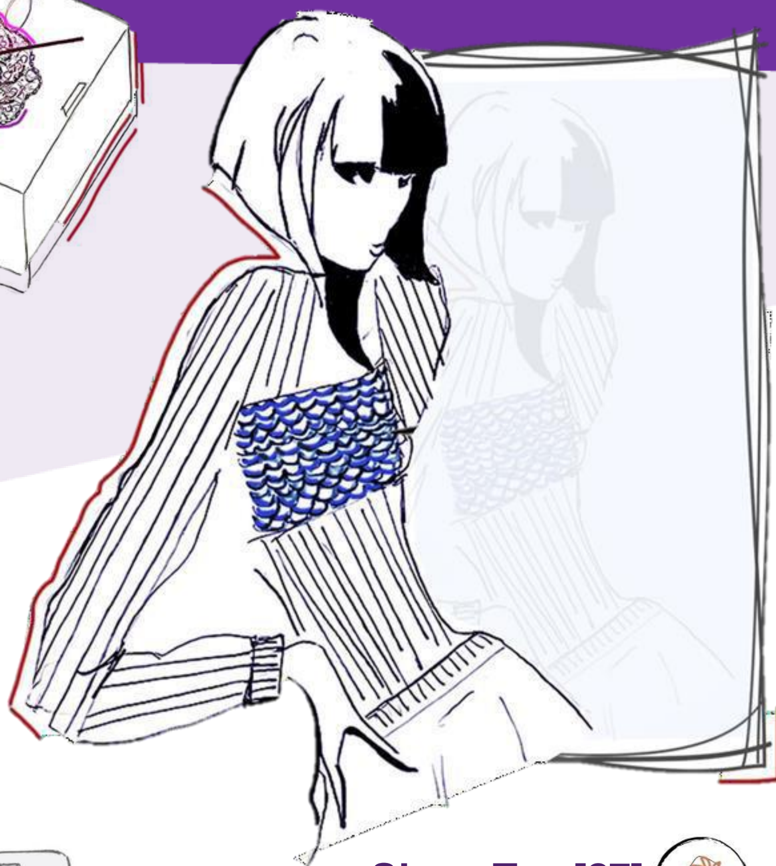


Ebb [25]

A dynamic hand-woven textile display

Description: Ebb by Devendorf, et al. [25] explores the potential and perceptions of dynamic displays on clothing. Using conductive threads coated with thermochromic paint, the researchers developed a dynamic textile display called Ebb, in the form of woven and crochet fabric swatches. They maintain the ambiguous, ambient, and abstract display can enhance personal style and prompt aesthetic experiences in everyday life.

Fashion aspects: Woven crochet has made a significant comeback, blending vintage and modern styles with intricate patterns and nostalgic charm. Eco-friendly options appeal to sustainable fashion trends. Dynamic color-changing features and ambient, low-resolution changes add a magical element, allowing wearers to adapt their look to different contexts, enhancing versatility and personal expression and style [25].



Polymeric optical fibre (POF) knitted garment [21]

A knitted POF raglan jumper

Description: ShapeTex by Du, et al. [16] attempted to create a more appealing and fashionable form-fitting illuminated Polymeric Optical Fibre (POF) garments by incorporating POF directly into the looped structure. They produced a tight-fitting knitted raglan sleeve jumper with a section of knitted POF demonstrating new aesthetics.

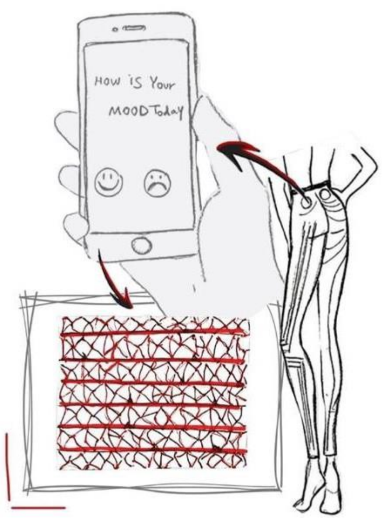
Fashion aspects: Incorporating illuminating POF into garments, as an embellishment [21], enables dynamic lighting effects, creating striking and adaptable patterns. The seamless integration of the POF into the knit preserves flexibility and comfort while adding a unique visual element. The form-fitting design demonstrated by a tight-fitting jumper with POF sections can enhance fashionable and functional features.

The Textile Mirror [31]

A wall panel of connected fabric flowers

Description: The Textile Mirror by Fox [31] is made up of 80 pieces of laser-cut felt and fused together with Nitinol wire. It includes a series of motors permitting movement, which changes shape in response to people's emotions. The heart sensors and galvanic skin sensors attached to the clothing and a smartphone connected to the textile mirror allow it to read the emotions and change form.

Fashion aspects: The Textile Mirror include voluminous pieces which respond to human emotions through contraction (folding) and expansion, offering unique aesthetic and fashionable aspects. The textile can dynamically change its appearance, texture, color, and patterns based on the wearer's emotional state, creating a visually captivating and engaging garment. The dynamic and kinetic features of the textile enhance personal expression, customization, and versatility, aligning with contemporary fashion trends that emphasize individuality and adaptability [35].



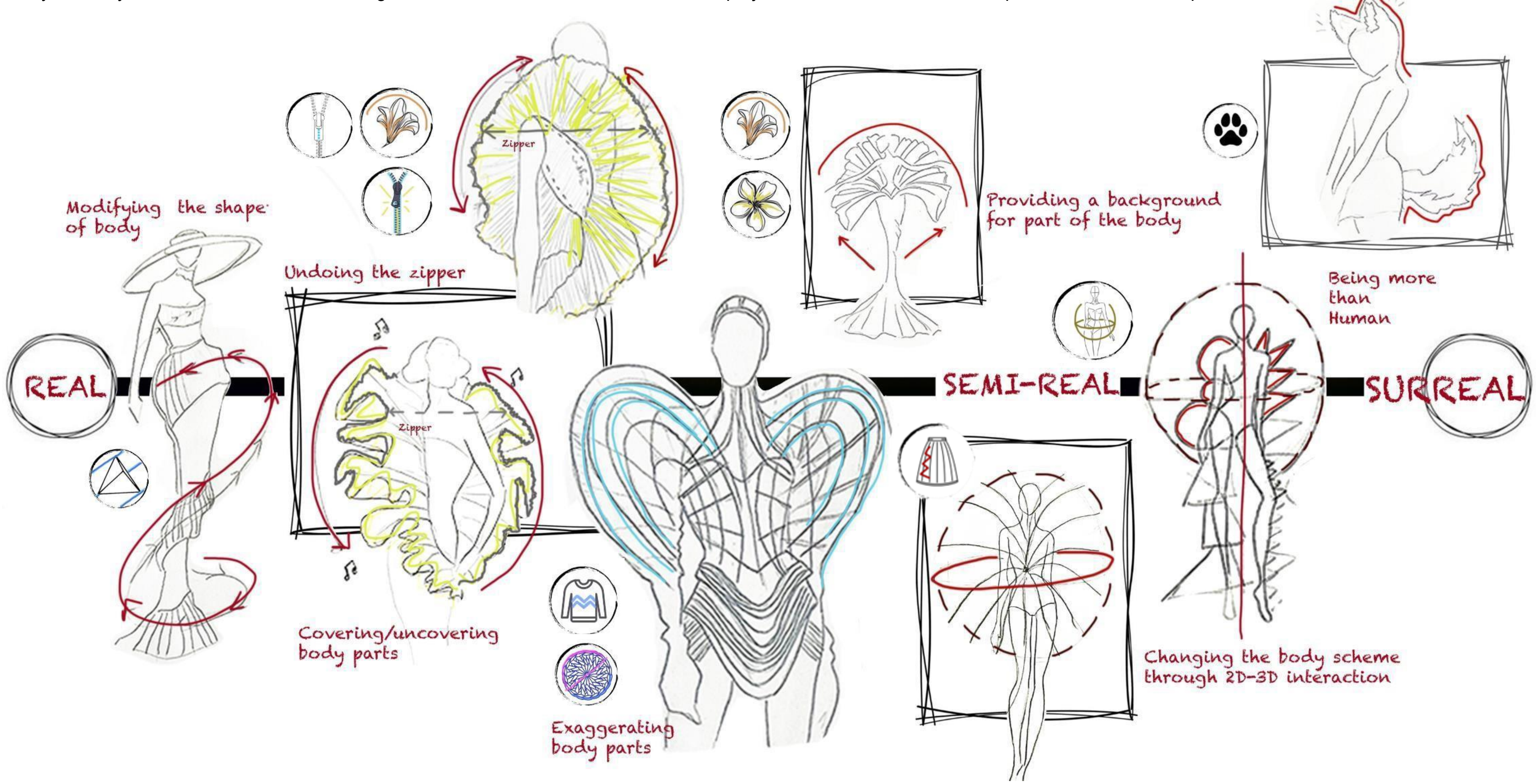
ShapeTex [27]

A thermal shape changing fabric

Description: ShapeTex by Chen, et al. [27] is a thermal shape-changing fabric using laminate thermal expansion. Researchers developed concept prototypes like the Willow Cap, a hat with touch-sensitive ShapeTex leaves, and the Textile Garden, an exhibit with moving flowers symbolizing sustainability. The Crazy Coil hat exaggerates emotions with heat sensors, while the Botanic Hat blooms in response to the wearer's heartbeat.

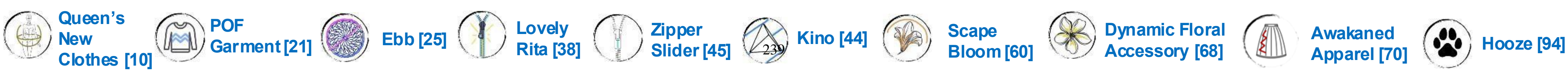
Fashion aspects: The ShapeTex artefacts blend innovative shape-changing structures with nature-inspired fashion. to generate visual aesthetics and fashionable functionality; the visibility of metal patterns and the wires of the circuit board in the form of leaves can contribute to aesthetic aspects [35].

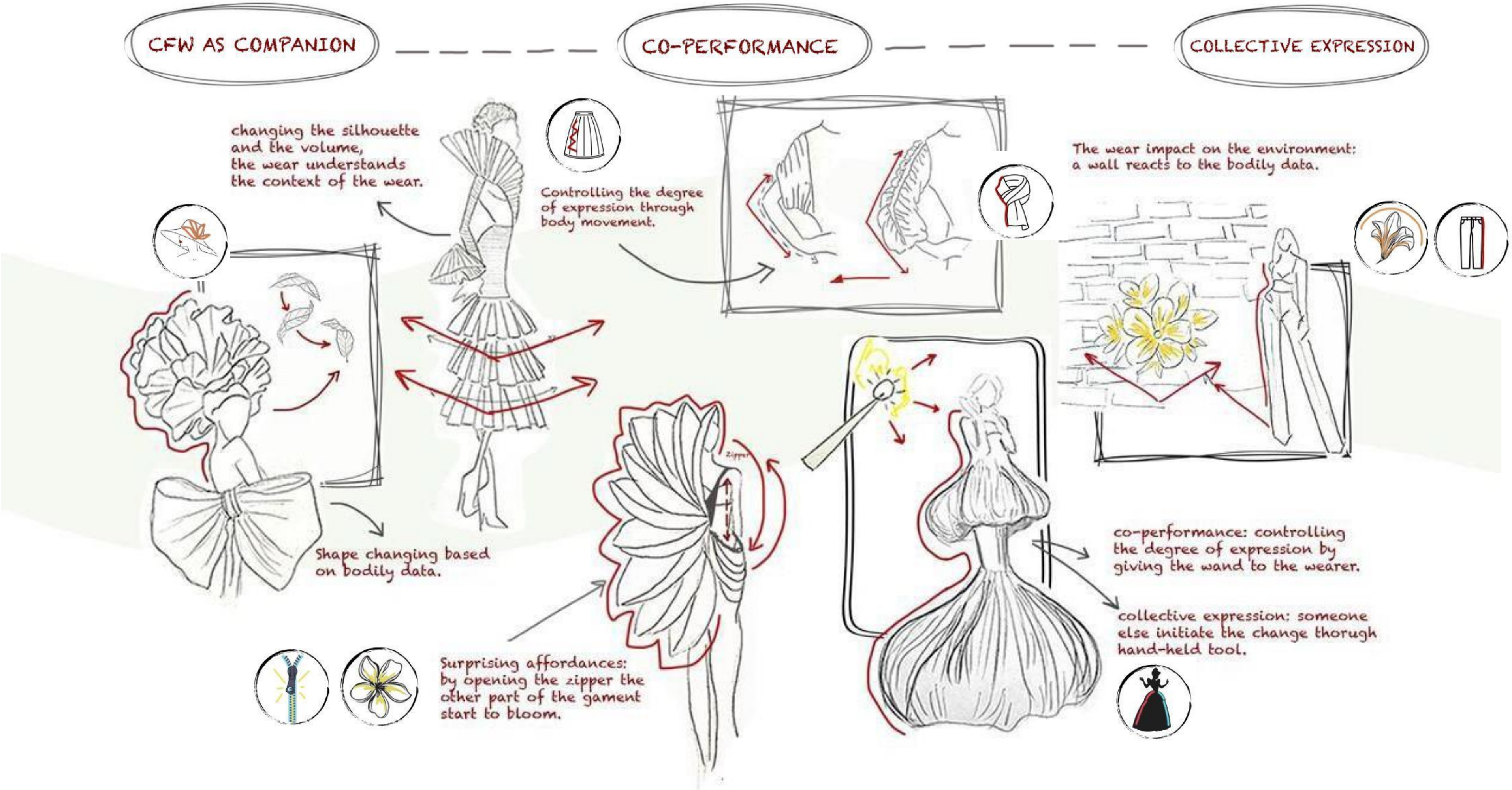
By applying the Reflective Thematic Analysis (RTA) method [14] and interpretive sketching inspired by the CFWs' designs in the study papers, we generated three directions, which are elaborated below. Additionally, to clarify the connections in the sketching illustrations, an icon was created for each project in this visual review that inspired the extensions depicted below.



AUGMENTED EXPRESSIONS IN CFWS: From Real to Surreal

The first design direction coming out from our RTA is AUGMENTED EXPRESSIONS in CFWs, which draws on notions of cyborg aesthetics [37], [13]. These theoretical perspectives explore how technology and the human body co-construct identity, extending the body's expressive range beyond its natural boundaries. In CFWs, augmentation occurs when computational and fashion elements combine to amplify personal expression, along a real–surreal continuum. We adopted the name "Augmented Expressions" to refer to any kind of enhancement and amplification of personal expressions through materiality either computational or fashion elements in the wearable [34]. This direction includes a real-surreal continuum and refers to wearables that seamlessly blend practicality (technology) with fantasy (imagination). Wearables which consists of tangible aspects e.g., fabrics, sensors, touch, movement, or physiological signals modalities and serve practical purposes such as monitoring health or adapting to the environment (e.g., Robotic Flower & Lovely Rita) are mostly functional and placed at the real end of expression. At the **real** end, augmentations are grounded in the wearer's existing body form, through 1. Revealing or concealing body parts by means of zippers, and 2. highlighting body features by providing background and contour emphasis, or by modifying and exaggerating some body part(s) **[38], [44], [45], [60]**. At the **surreal** end, CFWs expand the body schema via kinetic, light-based, or volumetric projections. These wearables include shape-changing fabrics or LED patterns that evoke wonder, magical aesthetics, or even animal-like forms **[10], [21], [25], [68], [94]**. The Surreal end might seem a parody of fiction involving being another entity or being more than human (MtH) and feeling like having a superpower. The space between these two ends **(semi-real)** explores a harmonious fusion of tangible and imaginative aspects in wearables--for instance, kinetic elements in the Awakened Apparel **[70]** blend functional adaptation with aesthetic playfulness. This direction offers actionable strategies for designers including selecting fashion techniques such as proportion exaggeration, fabric manipulation, and embellishment [91], [81], [16], [76], [41] to emphasize targeted body zones; mapping interaction modalities (e.g., touch, movement, physiological sensing) to aesthetic transformations along the real–surreal spectrum; prototyping 2D–3D transitions to create dynamic silhouettes; and embedding surreal elements within coherent narrative framings that give them meaning for the wearer.

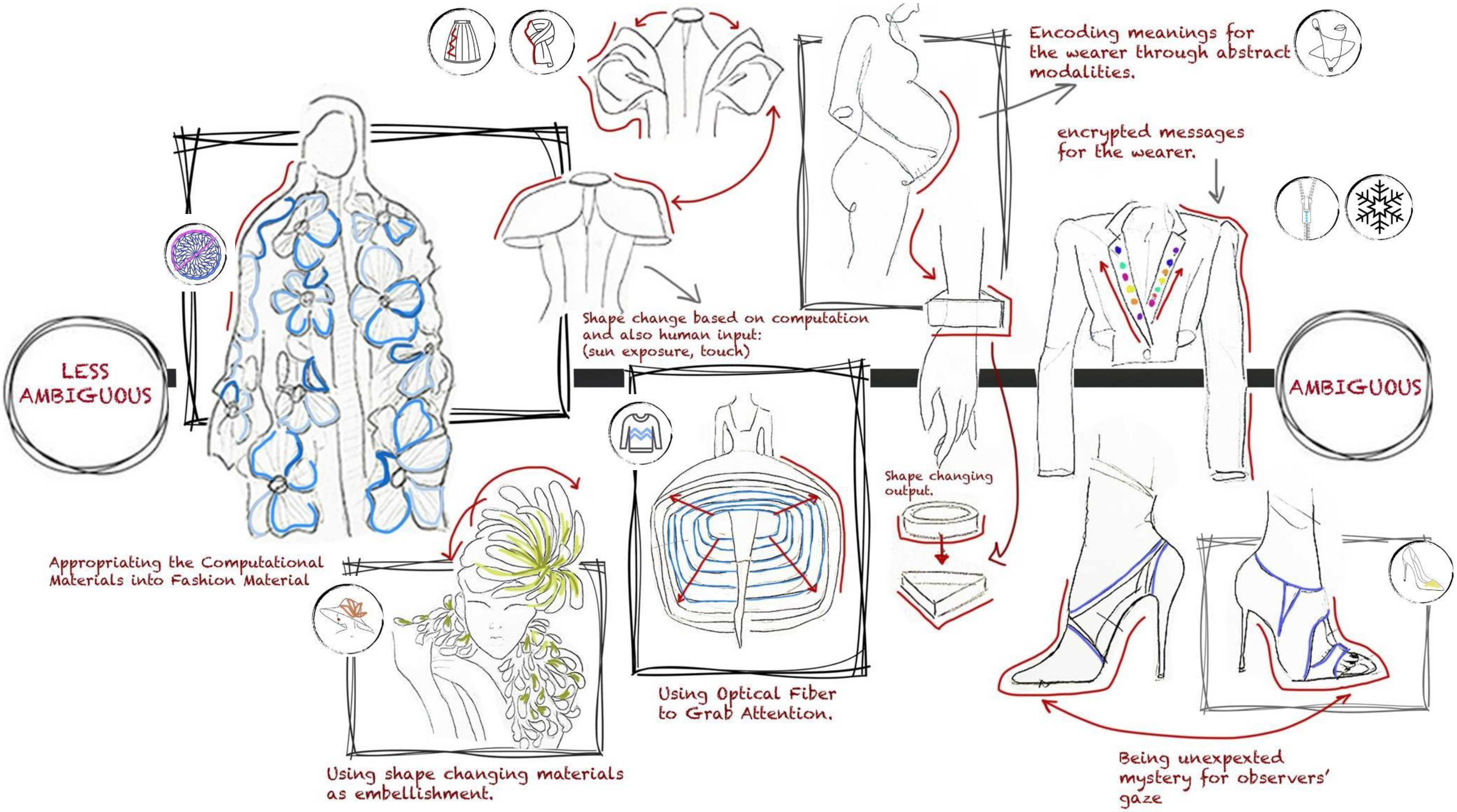




DIALOGIC EXPRESSIONS IN CFWS: COmpanion, CO-Performance, COllective Expressions

'Dialogic Expressions in CFWs', the second design direction, is rooted in Mikhail Bakhtin's work and highlights the importance of dialogue in constructing meaning [4]. The concept of "dialogic expressions" metaphorically represents various embodiments and manifestations resulting from interactions between the wear, wearer, and environment. In CFWs, dialogic expressions materialize when the wear, the wearer, and the environment dynamically collaborate to produce expressions that may be personal, shared, or negotiated. Three sub-modes emerged from our analysis. In the **companion** mode, wearables autonomously express on behalf of the wearer. They interpret both contextual cues and the wearer's bodily data, externalizing internal states and transforming this information into fashionable expressions—such as altering silhouette or volume—to visually communicate the wearer's condition or mood **[27], [38], [68]**. In the **co-performance** mode, the wear and the wearer co-operate in the expression; however, the wearer retains control over the expressive output, adjusting parameters through gestures, tools, or posture **[9], [60], [70], [90]**. Finally, in the **collective expression** mode, the wearable acts as a bridge to other people and/or surroundings in two ways: 1. The wearer is not in control and external agents in the surrounding can decide or initiate the change with, for example, a wand. 2. The wear impacts on the environment so that objects in there, for example, a wall reacts to the bodily data **[9], [31]** and **[60]**. Dialogic Expressions suggest actionable design strategies such as incorporating bidirectional sensing to allow wearables to both read and respond to contextual cues; employing fashion detailing such as silhouette shifts, volume modulation, and fabric surface changes to enhance interactional affordances [51], [81], [16], [76], [41]; developing explicit interaction grammars (design frameworks) for each sub-mode to specify triggers (e.g., gestures, biometric input, environmental changes), degrees of wearer agency, and modes of audience participation; and prototyping networked expressions that connect multiple wearers or link wearables to responsive environments.

Sleeping Beauty [9] · **ShapeTex [27]** · **Textile Mirror [31]** · **Lovely Rita [38]** · **Scape Bloom [60]** · **Dynamic Floral Accessory [68]** · **Awakaned Apparel [70]** · **Scarfy [90]**



AMBIGUOUS EXPRESSIONS IN CFWS: Turning Precision into Enigma

The third design direction, Ambiguous Expressions in CFWs, is informed by the concept of aesthetic ambiguity [33], in which open-endedness invites interpretation and personal meaning-making. Most of the reviewed CFW projects base their expressions on precise sensor data such as temperature or heart rate and transform them into enigmatic displays that require decoding by observers, thereby generating intrigue and deeper engagement. Our analysis identified three main strategies for achieving such ambiguity. First, **material–computation appropriations** integrate computationally active materials into fashion surfaces, creating expressions that are unexpected or unfamiliar to the observer's gaze **[21], [25]**. Second, **temporal ambiguity** uses slow, unpredictable transformations—such as shape-shifting embellishments—through the interplay between by the wearer's bodily data and environmental impact **[27], [70], [90]**. Third, **encoded illuminations employ optical fibers or LED animations** in wearables for performances and special occasions to convey layered or cryptic messages, which may be legible only to the wearer or a select audience **[17], [20], [61]**. Ambiguous expressions in CFWs offer actionable design approaches including creating multi-layered visual codes that offer different readings (interpretations) for different audiences, depending on the viewer's perspective or familiarity with the wearable's "visual language" [33]. They can include slow, non-linear transitions in color, form, or illumination to deliberately delay recognition and encourage sustained observation. Context-dependent mappings that integrate both environmental inputs (e.g., light, temperature, ambient sound) and the wearer's bodily data (e.g., heart rate, motion) can introduce variability and unpredictability into the garment's responses. Finally, audience interpretation studies can be conducted to iteratively refine these expressions, ensuring they fine-tune a balance between intrigue and communicative clarity.

Snowflakes Jewelry [17, 39] · **Trace and Fibo [20]** · **POF Garment [21]** · **Ebb [25]** · **ShapeTex [27]** · **Zipper Slider [38]** · **Dynamic High Heels [61]** · **Awakaned Apparel [70]** · **Scarfy [90]**

DISCUSSION

We conducted a Visual Literature Review (VLR) of CFWs and used reflexive thematic analysis (RTA) to generate three design macro-themes as **actionable directions.** Due to the lack of access to the original prototypes, we found it quite useful to engage in the literature through drawing modality to explore wearables' possibilities and affordances. As "a fully haptic and multi-sensory reality of imagination" [67], sketching communicates ideas through visual dialogue [49] and supports ideation, storytelling, and stakeholder engagement in HCI [83], [84]. **Immersing ourselves in the data, we generated three actionable directions: Augmented Expressions,** highlighting cyborg aesthetics, adaptive fabrics, and superhuman augmentation; **Dialogic Expressions,** emphasizing fluid identities through human–nonhuman interactions; **and Ambiguous Expressions,** reflecting interpretive uncertainty and techno-utopian visions of progress, abundance, and seamlessness [47]. These directions illustrate how wearables increasingly bridge human and technological capabilities, embodying transformative post-humanist concepts.

Augmented Expressions extend the body's expressive range along a real–surreal continuum, blending practicality with fantasy. At the "real" end, wearables integrate computational elements into the garment's style and silhouette, subtly altering proportion, shape, or detailing to influence the wearer's spatial presence [38], [44], [45], [60]. At the surreal end, they adopt experimental aesthetics—kinetic structures, body projections, shape-changing fabrics, or light-responsive textiles—that transcend bodily limits through magical aesthetics, animal-like morphologies, or speculative post-human forms [10], [21], [25], [44], [68], [90], [94]. Between these poles, hybrid designs (e.g., Awakened Apparel [70]) combine functionality and playfulness while remaining socially acceptable [10]. Philosophically grounded in cyborg aesthetics, this continuum challenges the nature–technology binary, positioning the augmented body as a negotiated construct. In practice, designers can map interaction modalities—touch, motion, physiological sensing—onto aesthetic transformations, framing surreal elements within narrative contexts for cultural legibility.

Dialogic Expressions position CFWs as relational agents in meaning-making, grounded in Bakhtin's dialogism. Here, wearables converse with the wearer, others, and the environment through three sub-modes: Companion, where artefacts autonomously respond to bodily data (e.g., silhouette modulation by heart rate) [27], [38], [68]; Co-performance, where the wearer co-directs expressions via gesture, posture, or tools [9], [60], [70], [90]; and Collective Expression, where external agents or environments trigger shared performances [9], [31], [60]. This relational framing parallels theories in HCI and design that treat artefacts as co-performers in situated expression. For practice, it calls for explicit interaction grammars detailing triggers, wearer control levels, and audience participation, as well as prototypes for networked expressions linking multiple wearers or responsive spaces.

Ambiguous Expressions draw on Gaver et al.'s view of ambiguity as a resource, using interpretive uncertainty to deepen engagement [33]. In CFWs, this can emerge through material–computation proportions [21], [25], temporal ambiguity with slow, unpredictable transformations [27], [70], [90], and encoded illuminations that convey layered or cryptic messages [17], [20], [61]. Such strategies encourage multiple readings, challenge assumptions, and sustain intrigue. Philosophically, they resonate with techno-utopian imaginaries of progress (effortless living), abundance (infinite resources), and seamlessness (invisible integration of tech into fashion) [47], while pragmatically requiring a balance between mystery and communicative clarity. Designers can combine environmental and bodily data to maintain unpredictability, and conduct audience interpretation studies to refine meaning and engagement.

The three design directions identified in this study—Augmented Expressions, Dialogic Expressions, and Ambiguous Expressions—are grounded in distinct yet interrelated philosophical traditions that illuminate how computational fashion wearables (CFWs) mediate human–technology relations. Augmented Expressions draw on cyborg aesthetics, particularly [37]'s and [13]'s conceptualization of the cyborg as a hybrid entity that dissolves the boundaries between human and machine, enabling the co-construction of identity through material and interactive affordances. In CFWs, this manifests in adaptive, shape-changing fabrics, soft robotic suits, and speculative "superhuman" augmentations that extend bodily morphology or sensory capacity beyond biological limits. Dialogic Expressions, informed by Bakhtin's notion of dialogism [4], reconceptualize wearables as conversational agents embedded in reciprocal meaning-making with the wearer, other people, and the surrounding environment. Here, wearables operate in modes such as Companion (autonomous expression based on bodily data), Co-performance (wearer-directed modulation), and Collective expression (multi-wearer or environment-driven displays), aligning with relational design perspectives that position artefacts as collaborators rather than passive tools. Ambiguous Expressions engage with Gaver et al.'s theory of ambiguity as a design resource [33], using strategies such as material–computation hybrids, temporally unpredictable transformations, and encoded illuminations to invite layered readings that resist immediate legibility. Together, these directions embody post-humanist perspectives, in which subjectivity is fluid, decentered, and materially entangled with technology, positioning CFWs as not merely functional artefacts but as co-creative agents in emergent forms of being, sensing, and expression.

While these three design directions outline the conceptual and philosophical contours of CFWs, their realization in practice depends on a designer's ability to create sensorially compelling and materially expressive garments. Sensual engagement plays a central role in aesthetic experiences, as design objects appeal to the senses and forge meaningful connections [30]. Research in computational fashion wearables (CFWs) [41], [34], [66], [92], [50] underscores that incorporating conventional fashion design elements—such as silhouette, proportion, shape, detailing, embellishment, and fabric manipulation—can significantly enhance fashionability and shape wearer preferences. Our review of prior CFW studies shows how these techniques, whether applied individually or in combination, have been used to create both subtle and flamboyant forms of expression. For example, dynamic on-body robots, floral embellishments, augmented zippers, and shape-changing fabrics can either harmonize with the body's natural form or dramatically reconfigure its proportions, as seen in Augmented Expressions. Furthermore, data-driven adaptability, context-responsiveness, and enhanced communicative capacity in wearables foster a continuous negotiation between the wearer and the garment in shaping fashionable expressions, aligning with Dialogic Expressions. Designers should, therefore, consider the degree, mode, and agency of control when implementing these elements. Finally, these same techniques can also cultivate interpretive openness, drawing on the inherently indirect nature of fashion to translate precise, sensor-derived data into more ambiguous and experientially rich forms, as in Ambiguous Expressions.

LIMITATIONS

While these findings offer actionable insights, they must be interpreted within the study's limitations. Our review primarily considered academic and research-based CFW projects, potentially excluding commercially produced works with different aesthetic and production priorities [41]. This narrows the representativeness of our synthesis and calls for future studies that integrate both academic and industry perspectives. Methodologically, while sketching proved valuable for abstraction and ideation, it cannot fully capture the temporal and kinetic qualities of dynamic wearables—especially those incorporating movement, light, or responsive materials. Moreover, our analysis relied on secondary visual and textual documentation rather than direct artefact engagement, limiting our understanding of materiality, tactility, and situated use. Finally, the interpretive nature of fashion aesthetics means our thematic framing reflects the researchers' positionality. Future research could triangulate this approach with audience reception studies, designer interviews, and in-situ ethnographic observations, yielding a richer and more multifaceted account of CFW aesthetics in practice.

CONCLUSION

Computational fashion wearables (CFWs) extend far beyond functionality, with design aesthetics shaping their attractiveness, cultural resonance, and perceived value [23], [63], [92]. This pictorial contributes to the field by foregrounding the aesthetic dimensions of CFWs through a novel combination of Visual Literature Review (VLR) and reflexive thematic analysis (RTA), supported by sketching as both a generative and analytical tool. By visually synthesizing a diverse corpus of academic CFW projects, we reveal how designers employ both traditional fashion techniques—such as silhouette, proportion, detailing,

and fabric manipulation—and computational affordances to create rich sensory, cultural, and narrative experiences.
Our analysis generated three interconnected design directions: Augmented Expressions, which span from static adornment to dynamic canvas,(from subtle sartorial enhancements to experimental, shape-changing, and light-responsive forms); Dialogic Expressions, in which wearables act as companions, co-performers, or collective agents; and Ambiguous Expressions, which leverage interpretive uncertainty to sustain intrigue through slow transformations, multi-layered codes, and context-responsive mappings. Together, these directions illuminate how CFWs bridge human and technological capabilities, embodying post-humanist ideas of fluid identities and materially entangled agency.

While this study is limited by its focus on academic projects, reliance on secondary documentation, and the static nature of sketches in representing dynamic artefacts, it is an important steppingstone for the demonstration of the wearables field from a fashion design perspective, and it offers an annotated visual portfolio that consolidates aesthetic strategies across the field. As such, it provides both an inspirational resource and a methodological precedent for researchers and practitioners seeking to explore the sensorial, cultural, and philosophical possibilities of CFWs. By positioning aesthetics not as an afterthought but as an integral driver of interaction design, this work sets the stage for future interdisciplinary research, encouraging the creation of wearables that are not only technologically advanced but also culturally legible, emotionally engaging, and imaginatively compelling.

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REFERENCES

1. *Abraham, E. (2023, April 19). Minimalist fashion women: A guide to aesthetic & simplistic style. In The Blouse. https://www.theblouse.com/minimalist-fashion-aesthetic-style-guide/*
2. *Andersson, T. (2016). Aesthetic flexibility: modularity of visual form in product portfolios and branded products (Doctoral dissertation, Linköping University Electronic Press).*
3. *Aspers, P., & Godart, F. (2013). Sociology of fashion: Order and change. Annual Review of Sociology, 39, 171-192.*
4. *Bakhtin, M. M. (2010). The dialogic imagination: Four essays. University of Texas Press.*
5. *Barnard, M. (2003). Fashion as Communication (2nd ed.). Routledge. DOI: 10.4324/9781315013084*
6. *Barnard, M. (2014). Fashion theory: An introduction. Routledge.*
7. *Barthes, R. (1983). The fashion system. Univ of California Press.*
8. *Benjamin, W. (2008). The work of art in the age of mechanical reproduction. In H Arendt (Ed.), Illuminations (pp. 217–252). Schocken Books.*
9. *Berglund, M. E., Foo, E., Molla, M. T. I., Sudheendra, S. M., Compton, C., & Dunne, L. E. (2018, October). MAKE IT BLUE: a controllable, color-changing dynamic costume. In Proceedings of the 2018 ACM International Symposium on Wearable Computers (pp. 236-241).*
10. *Bian, L., Yao, L., & Hirsch, M. (2017, November). Power-on clothes. In Proceedings of the 9th International Conference on Advances in Computer Entertainment Technology (pp. 1-2).*
11. *Bourdieu, P. (2018). Distinction a social critique of the judgement of taste. In Inequality (pp. 287-318). Routledge.*
12. *Bown, O., Grace, K., Bray, L., & Ventura, D. (2020). A Speculative Exploration of the Role of Dialogue in Human-Computer Co-creation. In ICCC (pp. 25-32).*
13. *Braidotti, R. (2013). Posthuman humanities. European Educational Research Journal, 12(1), 1-19.*
14. *Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology.* Qualitative Research in Psychology, 3(2), 77-101.
15. *Buxton, B. (2010). Sketching user experiences: getting the design right and the right design. Morgan kaufmann.*
16. *Burns, A. (2022). Rethinking fabric: The application of fabric manipulation techniques in fashion design education. International Journal of Art & Design Education, 41(1), 66–80. https://doi.org/10.1111/jade.12375*
17. *Buruk, O. C., Genç, Ç., Yıldırım, I. O., Onbaşlı, M. C., & Özcan, O. (2021, May). Snowflakes: A prototyping tool for computational jewelry. In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (pp. 1-15).*
18. *Calderin, J., & Volpintesta, L. (2013). The Fashion Design Reference & Specification Book: Everything Fashion Designers Need to Know Every Day. Rockport Publishers.*
19. *Carey, L., & Cervellon, M. C. (2014). Ethical fashion dimensions: pictorial and auditory depictions through three cultural perspectives. Journal of Fashion Marketing and Management, 18(4), 483-506.*
20. *Carpenter, V. J., & Overholt, D. (2018). Designing for interpersonal connections in future technologies: An annotated portfolio of jewelry devices. DIS '18: Proceedings of NordDesign 2018, Linköping, Sweden, 13th-17th August 2018.*
21. *Chen, A., Tan, J., Henry, P., & Tao, X. (2020). The design and development of an illuminated polymeric* polymeric optical fibre (POF) knitted garment. The Journal of The Textile Institute, 111(5), 745-755.
22. *Chen, T., & Peng, L. (2019). Nature-inspired fashion design through the theory of biomimicry. Yuntech, Graduate School of Design, Master & Doctoral Program, (11).*
23. *Chuah, S. H. W., Rauschnabel, P. A., Krey, N., Nguyen, B., Ramayah, T., & Lade, S. (2016). Wearable technologies: The role of usefulness and visibility in smartwatch adoption. Computers in Human Behavior, 65, 276-284.*
24. *Contemporist. (2017, March 27). 10 modern and creative fashion designs inspired by origami. https://www.contemporist.com/10-fashion-designs-inspired-by-origami/*
25. *Devendorf, L., Lo, J., Howell, N., Lee, J. L., Gong, N. W., Karagozler, M. E., ... & Ryokai, K. (2016, May). "I don't Want to Wear a Screen": Probing Perceptions of and Possibilities for Dynamic Displays on Clothing. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (pp. 6028-6039).*

26. Dewey, J. (1934). Art as Experience (Perigee Trade Paperback Edition). New York, NY: Minton, Balch & Company.
27. Du, J., Markopoulos, P., Wang, Q., Toeters, M., & Gong, T. (2018, March). ShapeTex: implementing shape-changing structures in fabric for wearable automation. In Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction (pp. 166-176).
28. Dunne, L. (2010). Beyond the second skin: an experimental approach to addressing garment style and fit variables in the design of sensing garments. International Journal of Fashion Design, Technology and Education, 3(3), 109-117.
29. FloraQueen. (2023, August 29). The influence of flowers in fashion. Retrieved from https://www.floraqueen.com/blog/the-influence-of-flowers-in-fashion
30. Folkmann, M. N. (2023). Design Aesthetics: Theoretical Basics and Studies in Implication. MIT Press.
31. Fox, T. (2020). Smart textiles respond to human emotions. MRS Bulletin, 45(9), 694-696.
32. Gaver, B., & Bowers, J. (2012). Annotated portfolios. interactions, 19(4), 40-49.
33. Gaver, W. W., Beaver, J., & Benford, S. (2003, April). Ambiguity as a resource for design. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 233-240).
34. Genç, Ç., Buruk, O. T., Inal, S., Can, K., & Özcan, O. (2018). Exploring Computational Materials as Fashion Materials: Recommendations for Designing Fashionable Wearables.
35. Genç, Ç., Buruk, O. T., Özcan, O., Yılmaz, S. I., & Can, K. (2017). Forming visual expressions with augmented fashion. Visual Communication, 16(4), 427-440.
36. Greenberg, S., Carpendale, S., Marquardt, N., & Buxton, B. (2012). Sketching user experiences: The workbook. Elsevier.
37. Haraway, D. (2006). A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late 20th Century. In: Weiss, J., Nolan, J., Hunsinger, J., Trifonas, P. (eds) The International Handbook of Virtual Learning Environments.Springer,Dordrecht. https://doi.org/10.1007/978-1-4020-3803-7_4
38. Hye, L. M., & Achituv, R. (2012, February). Lovely Rita. In Proceedings of the Sixth International Conference on Tangible, Embedded and Embodied Interaction (pp. 325-326).
39. Insel, S., Buruk, O. T., Onbaşlı, M. C., & Özcan, O. (2018, April). Snowflakes: A Design Speculation for a Modular Prototyping Tool for Rapidly Designing Smart Wearables. In Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (pp. 1-6).
40. Islam, A., He, T., Bezerianos, A., Lee, B., Blascheck, T., & Isenberg, P. (2023). Visualizing Information on Smartwatch Faces: A Review and Design Space. arXiv e-prints, arXiv-2310.
41. Jabari, S., Shaikh, A., Genç, Ç., Buruk, O., Virkki, J., & Hamari, A. (2023). A Systematic Literature Review on Computational Fashion Wearables. International Journal of Human–Computer Interaction, 1-28.
42. Jones, A. (2019, March 28). Flower power: How our obsession with flora is transforming the aesthetics of design, art and fashion. We Heart. Retrieved from https://www.weheart.com/2017/06/15/flowers-in-art-design-fashion/
43. Joseph, F., Smitherman, M., Cleveland, D., Stephens, C., & Fisher, H. (2017). Digital materiality, embodied practices and fashionable interactions in the design of soft wearable technologies. International Journal of Design, 11(3), 7–15.
44. Kao, H. L., Ajilo, D., Anilionyte, O., Dementyev, A., Choi, I., Follmer, S., & Schmandt, C. (2017, June). Exploring interactions and perceptions of kinetic wearables. In Proceedings of the 2017 Conference on Designing Interactive Systems (pp. 391-396).
45. Kim, J. E., Kim, Y. H., Oh, J. H., & Kim, K. D. (2017). Interactive smart fashion using user-oriented visible light communication: The case of modular strapped cuffs and zipper slider types. Wireless Communications and Mobile Computing, 2017.
46. Kim, S. Y. (2009). Characteristics of Fur Design in the Contemporary Fashion: Mainly Focused on Works after the Year 2000. Journal of the Korean Society of Clothing and Textiles, 33(4), 563-573.
47. King, M. F. (2011). Fashion, the body and technology: Tracing early 20th century technoutopian ideas, aesthetics and impulses in 21st century wearable technology (Doctoral dissertation, Queensland University of Technology).
48. Kooroshina, M., Thornquist, C., & Clausen, L. (2015). Performative interactions between body and dress: thermochromic print in fashion. International Journal of Fashion Design, Technology and Education, 8(1), 47-53.
49. Kouliidou, N., Wallace, J., Sturdee, M., & Durrant, A. (2020, July). Drawing on experiences of self: Dialogical sketching. In Proceedings of the 2020 ACM Designing Interactive Systems Conference (pp. 265-267).
50. Lee, E. J. (2020). Gender influence in the effect of design aesthetics on perceived product value of wearables. International Journal of Advanced Culture Technology, 8(2), 129-138.
51. Lee, J., & Steen, C. (2014). Technical sourcebook for designers. A&C Black.
52. Levian, S. (2023, July 28). Symbolism and Cultural Significance of Jewelry in Different Societies. Retrieved from https://sheenastone.com/blogs/journal/symbolism-and-cultural-significance-of-jewelry-in-different-societies
53. Lewis, D. M., Russell, E. M., Al-Shawaf, L., Ta, V., Senvieli, Z., Ickes, W., & Buss, D. M. (2017).

Why women wear high heels: Evolution, lumbar curvature, and attractiveness. Frontiers in Psychology, 8, 1875.

54. Lewis, M., & Sturdee, M. (2022). Curricula design & pedagogy for sketching within HCI & UX education. Frontiers in Computer Science, 4, 826445.
55. Lewis, M., Sturdee, M., & Marquardt, N. (2018, April). Applied sketching in HCI: Hands-on course of sketching techniques. In Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (pp. 1-4).
56. Löwgren, J. (2013). Annotated portfolios and other forms of intermediate-level knowledge. interactions, 20(1), 30-34.
57. Lorenzi, M. G., Mele, G., & Zecchetto, S. (2021). Geometrical and Fashion, the Case of Iris van Herpen. In Faces of Geometry. Lecture Notes in Networks and Systems, vol 172. Springer, Cham. https://doi.org/10.1007/978-3-030-63702-6_14
58. Mackey, A., Wensveen, S., Wakkary, R., Hupfeld, A., & Tomico, O. (2019, March). Wearing Digital Shimmers: A fashion-centric approach to wearable technology. In Research Through Design Conference 2019.
59. McCarthy, J., & Wright, P. (2004). Technology as experience. Interactions, 11(5), 42-43.
60. McMillan, C. (2019). Live: scape bloom: Connecting smart fashion to the IoT ecology. In Artificial Intelligence on Fashion and Textiles: Proceedings of the Artificial Intelligence on Fashion and Textiles (AIFT) Conference 2018, Hong Kong, July 3–6, 2018 (pp. 221-227). Springer International Publishing.
61. Mphepö, W., Gao, J., Li, M., Wang, J., Mengmeng, W., Dan, T., ... & Liu, Y. (2014, June). Wearable Display for Dynamic Spatial and Temporal Fashion Trends.
62. Mukhopadhyay, P. (2022). Ergonomics in Fashion and Accessory Products: Comfort and Functionality. In Ergonomics in Fashion Design: A Laypersons' Approach (pp. 29-37). Singapore: Springer Nature Singapore.
63. Muller, C. S., & de Klerk, N. (2020). Influence of design aesthetics and brand name on generation Y students' intention to use wearable activity-tracking devices. International Journal of eBusiness and eGovernment Studies, 12(2), 107-121.
64. Nguyen, U. (2020, July). Folding Fabric: Fashion from Geometry. In Proceedings of Bridges 2020: Mathematics, Art, Music, Architecture, Education, Culture (pp. 93-102).
65. Obendorf, H. (2009). Minimalism: designing simplicity. Springer Science & Business Media.
66. Oxford University Press. (n.d.). Aesthetics, n., sense 1.b. Oxford English Dictionary. Retrieved July 23, 2023, from https://doi.org/10.1093/OED/8485857749
67. Pallasmaa, J. (2009). The Thinking Hand: Existential and Embodied Wisdom in Architecture. Chichester, UK: Wiley.
68. Pan, C. H., & Pan, H. Y. (2018). Development of smart and dynamic floral clothing accessories. In Mechatronics 2017: Recent Technological and Scientific Advances (pp. 716-725). Springer International Publishing.
69. Patterson, T. (2017, August). The Innovation That Changed Fashion Forever. Bloomberg. https://www.bloomberg.com/news/articles/2017-08-25/history-of-the-zipper-an-innovation-that-changed-fashion-forever
70. Peverich, L., Mothersill, P., & Farah, J. B. (2014, February). Awakened apparel: embedded soft actuators for expressive fashion and functional garments. In Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction (pp. 77-80).
71. Perry, A., Malinin, L., Sanders, E., Li, Y., & Leigh, K. (2017). Explore consumer needs and design purposes of smart clothing from designers' perspectives. International Journal of Fashion Design, Technology and Education, 10(3), 372-380.
72. Petersen, M. G., Iversen, O. S., Krogh, P. G., & Ludvigsen, M. (2004, August). Aesthetic interaction: a pragmatist's aesthetics of interactive systems. In Proceedings of the 5th Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques (pp. 269-276).
73. Rasmussen, M. K., Pakanen, M., & Heiselsberg, K. (2024, June). A review of visual strategies in pictorials. In Proceedings of the 16th Conference on Creativity & Cognition (pp. 211-228).
74. Riisberg, V., & Folkmann, M. N. (2015). Exploring the Aesthetics of Sustainable Fashion.
75. Seneviratne, S., Hu, Y., Nguyen, T., Lan, G., Khalifa, S., Thilakarathna, K., ... & Seneviratne, A. (2017). A survey of wearable devices and challenges. IEEE Communications Surveys & Tutorials, 19(4), 2573-2620.
76. Seymour, S. (2019). Functional aesthetics. Ambra Verlag.
77. Shusterman, R. (2000). Pragmatist aesthetics: Living beauty, rethinking art. Rowman & Littlefield Publishers.
78. Simmel, G. (1957). Fashion. American journal of sociology, 62(6), 541-558. ps://doi.org/10.1086/222102
79. Smeilk, A., Toussaint, L., & Van Dongen, P. (2016). Solar fashion: An embodied approach to wearable technology. International Journal of Fashion Studies, 3(2), 287-303.
80. Sorensen, V., & Thummanapalli, N. (2017, September). Digital amulet: smart necklace. In Proceedings of the 2017 ACM International Symposium on Wearable Computers (pp. 238-243).
81. Sorger, R., & Udale, J. (2017). The fundamentals of fashion design. Bloomsbury Publishing.
82. Sturdee, M. (2025). A step toward formalising visual data analysis practices in human computer interaction. Interacting with Computers, iwae063.
83. Sturdee, M., & Lewis, M. (2020, April). Sketching in HCI: Research practice & publication (advanced). In Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems (pp. 1-4).

84. Sturdee, M., & Lindley, J. (2019, November). Sketching & drawing as future inquiry in HCI. In Proceedings of the Halfway to the Future Symposium 2019 (pp. 1-10). https://doi.org/10.1145/3363384.3363402
85. Swain, T. A., McNarry, M. A., & Mackintosh, K. A. (2024). Assessing and enhancing movement quality using wearables and consumer technologies: Thematic analysis of expert perspectives. JMIR Formative Research, 8(1), e56784.
86. Thompson, C. J., & Haytko, D. L. (1997). Speaking of fashion: consumers' uses of fashion discourses and the appropriation of countervailing cultural meanings. Journal of Consumer Research, 24(1), 15-42.
87. Toussaint, L. (2018). Wearing technology: When fashion and technology entwine (Doctoral dissertation, University of Nijmegen, the Netherlands).
88. Tzou, R. C., & Lu, H. P. (2009). Exploring the emotional, aesthetic, and ergonomic facets of innovative product on fashion technology acceptance model. Behaviour & Information Technology, 28(4), 311-322.
89. Van Dongen, P., & Toussaint, L. (2019). IN TOUCH WITH THE NOW: Stimulating Mindfulness through a Smart Denim Jacket. Arpita Artéz Journal. Retrieved February 14, 2021.
90. Von Radziewsky, L., Krüger, A., & Löchtefeld, M. (2015, January). Scarfy: augmenting human fashion behaviour with self-actuated clothes. In Proceedings of the Ninth International Conference on Tangible, Embedded, and Embodied Interaction (pp. 313-316).
91. Vuruskan, A., & Burns, A. (2017). An approach to develop creativity by understanding structure in fashion design education. Textile and Apparel, 27(1), 74–82. https://dergipark.org.tr/en/pub/tekstilvekonfeksiyon/issue/28634/306075
92. Wang, J., & Hsu, Y. (2020). The relationship of symmetry, complexity, and shape in mobile interface aesthetics, from an emotional perspective—A case study of the smartwatch. Symmetry, 12(9), 1403.
93. Worbin, L. (2010). Designing dynamic textile patterns (Doctoral dissertation, Chalmers University of Technology).
94. Zdziarska, P., Epp, F. A., Jensen, W., Gross, M. D., & Do, E. Y. L. (2019, March). Hooze: A Kinetic Fashion Accessory for Touch and Play. In Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction (pp. 407-413).