# RTD

Method&Critique *Frictions and Shifts in RTD*

# Wearing Digital Shimmers: A Fashion-centric Approach to Wearable Technology

**Angella Mackey[1,2], Stephan Wensveen[1], Ron Wakkary[1,3], Annika Hupfeld[1], Oscar Tomico[1,4],**

**[1] Eindhoven University of Technology, Eindhoven, The Netherlands**
*a.m.mackey, s.a.g.wensveen, r.l.wakkary, o.tomico, a.hupfeld @tue.nl,*

**[2] Philips Lighting Research, Eindhoven, The Netherlands**
*angella.mackey@lighting.com*

**[3] Simon Fraser, Surrey, Canada**
*ron_wakkary@sfu.ca*

**[4] ELISAVA, Barcelona, Spain**
*otomico@elisava.net*

**Abstract:** This paper describes an approach to designing wearable technology that sees and uses the technology expressively in terms of fashion, and minimizes the notion of its technological function. We do this by presenting an account of the research-through-design project Phem, a fashion brand concept for garments constructed with surface-changing, animated fabrics by way of augmented reality.

Phem consists of five outfits paired with varying 'digital shimmers' (discrete animated videos) presented through a short fashion film. The fashion film, which is a commonly used artefact of the fashion field, traditionally aims to synthesize a particular mood and style for its garments. In this case, the film also acts as a space for design inquiry where the temporal form of the digital shimmers can 'play-out' over time, on a particular body, and within a particular context.

Furthermore, in 'doing fashion' and letting expressivity be the guiding concern, we discuss how this approach differs from a prevalent technology-driven approach, and our deliberate attempt to avoid a futuristic aesthetic that dominates the field of wearables.

Method&
Critique

# Introduction

Over the last two decades there has been a surge of exploration, development and media hype surrounding the integration of dynamic materials and smart technologies into clothing (Berglin, 2013; Ryan, 2014; Stoppa and Chiolerio, 2014; Toussaint, 2018), widely recognized as the discipline of *wearables* or *wearable technology*. Related terminology includes *wearable computing, fashion and tech, fashionable technology* (Seymour, 2008), *techno-fashion* (Toussaint, 2018), *smart textiles, e-textiles* and *smart garments*. Although the differences between these terms are not always clear, making such distinctions is often required to articulate the precise implications and phenomena surrounding the notion of pairing technology with dress (Toussaint, 2018). Yet from the perspective of fashion, we postulate that these distinctions need not be made. When glasses, hats, handbags and watches can be seen as functional items embraced by fashion, or the Walkman and iPod which have been worn as fashionable accessories, we see that fashion has always made room for functionality in expressive ways.

Fashion functions to create expression for clothing (Loschek, 2009), adding layers of meaning, imagined experiences, and desires to what we wear. Because of this, designing garments requires a sensitivity to the materials that construct them—their qualities, behaviors, changing significance and social effects. With ideals for creating something fresh yet connotative, unique yet on trend, innovative yet wearable, and functional yet expressive, the fashion designer's job is one of balancing thresholds according to context. Throughout the design process a designer is engaged in conversation with their materials (Schön, 1992) in anticipation of an event—of the garment being worn, being seen, and in a way, being performed. It is in these moments that the clothing can become part of a fashion dialogue (Loschek, 2009; Mackey et al., 2017b).

## Our Inquiry

What we aim to examine throughout this paper and the work presented, are strategies for seeing and using technology expressively in terms of fashion, and minimizing the notion of their technological function. In other words, we aim to walk a line that uses computationally dynamic materials for "doing fashion" as opposed to "doing technology". We explore a fashion design process that deliberately but skeptically integrates technology—always evaluating it on its translation to fashion expressivity. We ask: How do dynamic materials and computational technologies translate through this performance of wearing garments in the world? How does a designer approach dynamic qualities that enable a garment to change shape, change colour, illuminate, or make sound? From the perspective of everyday dress, how does a designer accommodate these sorts of shifting states while maintaining a garment's expressive use of materials in a fashion context?

We examine these questions through the creation of Phem, a fashion brand concept for garments made with surface-changing, animated fabrics and presented through a fashion film. Describing the fabric is sometimes difficult in that it functions as a hybrid material with two states—virtual and physical. However, it can be understood as working similarly to augmented reality (AR) in that their appearance is altered in real-time through a smartphone screen using green and blue fabrics that can be composited with a chroma-key app. The *fashion film* format that we use to present them is a common artefact

of the fashion field (Uhlirova, 2013), traditionally aiming to synthesize a particular mood and style for its garments; attempting to yield desire for the clothing in support of the brand's image. We have used this medium as a vehicle and outcome of our design research process, thus forcing the technological qualities found in the hybrid clothing to be evaluated in terms of their ability to act as fashion. Furthermore, as the virtual forms of the clothing have qualities that make them unfixed in time and space, that require a clothing-wearing situation for them to become activated, the film format provides a platform for them to exist. In these ways, the film provides more than just a context for staging the garments, but also it co-shapes and co-generates their materiality as body-worn fashion objects.

We begin this paper by describing technology-centric trends we have identified for blending dynamic materials with clothing in the field of wearables versus the subtler more effective ways that fashion has approached this. Next, we describe how fashion can be used to add a layer of meaning onto clothing, and how the fashion film format plays an important role in this system. We then contextualize Phem by relating it to previous RtD work, and describe the Phem design process which includes conceptualising the brand, identifying and distilling the digital expressivity, implementing a strict editing process that values unity of concept over effects, and styling the digital shimmers through the pace of the fashion film. Finally, we conclude with a discussion for how this work might be beneficial to wearables designers, and reflections on our RtD approach.

# Background
## Finding a place for wearables in everyday life

In terms of the day-to-day clothing and accessories we wear, wearables have not become pervasive wardrobe items. Garments with integrated technologies often present dynamic materials with no previous heritage or social meaning in terms of everyday dress. Explicit visual changes in colour, shape, movement and other dynamic qualities have yet to make sense outside of entertainment or artistic contexts. Wearing light, as an example, has been thoroughly explored within wearable technology disciplines without finding social acceptance. Several illuminated garments have been made available for purchase over the last decade (e.g. Moon Berlin, Lumalive, Utope, Cute Circuit) without systemic changes to fashion despite much enthusiasm from media outlets.

Susan Elisabeth Ryan, in her book *Garments of Paradise*, describes early examples of wearable technologies aimed at being expressive for personal wear. One example is cited from 1867, where watchmaker Gustave Trouvé designed a hummingbird brooch with movable wings displayed at the Paris International Exposition, and later produced and publicized "a line of electronic jewels" with tiny 4V bulbs, only to find success in theatrical performance (Ryan, 2014). There have been patents filed in 1911 for an "Illuminated Vest or Coat Button" with lights "controlled by a concealed button...and powered by a battery in an interior pocket", as well as an electrically heated garment in 1925 (Ryan, 2014). Having occurred so long ago, it seems surprising to see these inventions reflect the current state of most wearable technologies in terms of the consumer market, that of novel ideas whose place is weakly prevalent in sports, work-specific, arts and entertainment contexts—but not in fashion.

Furthermore, motivations for integrating technology with garments often stem from persisting societal beliefs about technology—that we should do it "because we can" (Dunne, 2010) and that technology will free us from physical labor. In *Vogue*'s 1939 *Fashions of the Future* exhibition, designer Gilbert Rhode dressed in his version of "'the man of the future,' representing a 'revolt' from woolen suits and 'a lifetime spent buttoning and lacing...the ritual of fitting'" (Ryan, 2014). The suit was a loose-fitting jumpsuit with a vest that had a telephone attached at the center of it. These kinds of perspectives give a heightened status to future scenarios and assumptions that technological progress is always better than what we have. They forget that textiles, clothing, and even things like buttons and laces, have persisted for thousands of years, and that because of this there might be little room for improvement; that they are so culturally embedded that this cannot be disrupted by claims of efficiency. Clothing and fashion function to negotiate a person's identity in society, to ideally support their best or most authentic self in varying contexts that extends from rich histories of fashion and dress. Adding layers of hyper-dynamic movement, changing colour, illumination, and shape changes seems almost primitive compared to the subtler, multifaceted ways that clothing can already express who we are or want to be.

Frequently, aesthetic references for garments or accessories with dynamic behaviours draw from science fiction and other utopian/dystopian futuristic visions for body-worn technologies. They take inspiration from cyborgs, robots, alien biology, or the clean lines and minimalist tastes popularized by Mac (Manovich, Malina and Cubitt, 2001). Furthermore, as sports and activewear function to optimize

the wearer's performance, wearable technologies naturally fit into this genre and follow similar aesthetic "sportswear" cues, again favouring a minimalist aesthetic featuring smooth and curved lines. While there is nothing inherently problematic with smart garments following aesthetic threads drawn from cultural constructs of technology, as fashion objects this makes for a shallow pool of semantic reads that could be contributing to their niche existence.

What these examples illustrate is a prevalent technology-driven approach for integrating clothing and accessories with technology that do not draw from perspectives of clothing in terms of fashion. Certainly, there are seminal examples from fashion runway shows that demonstrate expressive explorations of dynamic materials such as Hussien Chalayan's Video Dress in 2007 and Viktor & Rolf's blue chroma-key dresses in 2002 (Uhlirova, 2013). Using the runway show format, they present highly stylized visions for technological garments that trigger the imagination yet still speak to the fashion tastes of the season. Similarly, our research explores a fashion-oriented approach to technology-integrated dress that prioritises this kind of provocative expressiveness.

As such, our research attempts to work in continuums of meaning where the expressivity of the digital aspect draws from cultural references not entirely connected to concepts of the future or sports, and situates digital aesthetics amongst everyday objects and things. From the perspective of design researchers working within a "wearable technology" context, we explore using fashion strategically for its

ability to build imaginary worlds surrounding clothing, while at the same time grounding it in references from everyday life. By deliberately avoiding or minimizing science fiction aesthetics, and by not venturing too far into the genre of artistic- or high-fashion, we seek a threshold in our design process that might bridge an understanding of fashion paired with dynamic materials to contemporary dress.

## How fashion gives meaning to clothing

The term 'fashion' is ambivalent. It can be understood as style trends of the moment, conjure images of runway models, refer to preoccupations with superficiality, be an inspiring art form, or be something we might try to achieve when getting dressed. For this paper and research, we use and define fashion as the system of reference and expressivity that enables garments to be social tools. We understand fashion as the layer on top of clothing that speaks to us, supported by multiple points of reference and forms of fashion media. As described by fashion theorist Ingrid Loschek (2009), 'Clothes, including accessories, are products which are realised by means of a design process. Which of the products are accepted and become fashion is determined by the society, a group within society or a single community...Fashion extends far beyond the objective aspect of the product, clothing. It gives this clothing social purpose, above and beyond those of function and aesthetics. Clothing is supplemented by semblance and illusion, which are defined as increased value or additional usefulness; in short, as fashion. '

The construction of fashion begins with garments being presented on a runway, through fashion magazines or other forms of advertising (Loschek, 2009). Here, designers and stylists can put forth an idealized, highly stylistic, vision surrounding the fashion image they wish to attach to the clothing. As Loschek writes "It is significant that we do not refer to a 'clothes show' or 'clothes photography', but to the 'fashion show' and 'fashion photography', for they grant the semblance and illusion of fashion to clothing. Fashion is far more than appearance; it is function and meaning." (Loschek, 2009)

At present, the fashion film is an important part of this fashion system. There are precursors to its current form that can be traced back to fashion's relationship with film and cinema over one hundred years ago (Uhlirova, 2013). Yet it has only truly come into being in the last fifteen years with the ubiquity of digital tools. Interestingly and most significant to this research, its format is valued for its ability to place fashion into explorations of time and movement. As Marketa Uhlirova (2013) writes, 'Above all, the fashion film has come to embody a growing interest, within the realms of fashion promotion, image-making, and experience, in the expressive and marketing possibilities of movement and time. Unlike photography and other static imagery, the fashion film unfolds in time (as if somehow fulfilling a potential only suggested in photography or illustration), and, unlike the fashion show, it fixes fashion as image. Still, the fashion film is understood here not in isolation from these forms, but rather through their intermedial links, which have intensified in the "digital age"...'

With fashion designers beginning to show more interest in technologies such as virtual reality (VR) (Arthur, 2016) and augmented reality (AR) (e.g. Normals, 2012; Weinmans and AugmentNL, 2013), and with the continued development of dynamic and smart materials, the film format provides a platform to communicate the experience

wearing them in terms of fashion. As we hope to demonstrate through our example of Phem, the fashion film provides a practical solution for exploring digital materials that possess a temporal form (Vallgårda et al., 2015) and intangible qualities, as well as naturally providing a situation charged with expressivity and reference.



**Figure 1.** Phem garments being worn by model who poses in the doorway of an old house. Photo: Angella Mackey

## Designing hybrid garments by 'doing fashion'
### Phem as a brand image that could exist today

Phem is preceded by a longitudinal, autoethnographic study called Greenscreen Dress that explored the lived experience of dynamic, surface-changing, fabric (Mackey *et al.* 2017a; Mackey *et al.*, 2017b). For one year the designer and researcher, and first-author of this paper, wore green fabric every day in conjunction with a chroma-key app to mimic the experience of dynamic garments. She composited videos onto her green clothing, and presented the garments being worn on Instagram so that they would have an audience. Findings from Greenscreen Dress included insights about the implications of wearing surface-changing fabrics, examinations of the speculations that had been previously made about such fabric, as well as a series of material explorations that played with the translation of digital videos through the physical materials (Mackey *et al.*, 2017a). Within an RtD context, the work demonstrated a mode of speculation that drew insights from the variables of a genuine social context, and gave the exploration enough time for changes and patterns to be identified.

Phem is the next step of this research building on selected insights from Greenscreen Dress and extending this particular kind of RtD approach. It moves the exploration of dynamic fabric from the perspective of one person wearing it, to forming a cohesive translation of it for a broader audience using fashion design. In order to approach pairing garments with technology differently from an observed techno-centric perspective or dominant futuristic aesthetic in the wearables field, our main strategy was to conceptualise a fashion brand that could theoretically exist today. This meant drawing inspiration from current fashion brands, making clothing that could be easily manufactured, planning for and collecting aritfacts to support an eventual social media presence, and generally trying to see and work in continuums of meaning and contemporary reference. This approach was strategically designed to "ground" the results in a contemporary context and make something expressive without venturing too far into an art- or high-fashion context.

The approach also meant removing the dominant speculative element from the previous work found in Greenscreen Dress. Instead of working with an "approximation of dynamic fabric" (Mackey *et al.*, 2017a), for Phem we explicitly made garments with surface-changing, animated fabric using an augemented-reality system. On the one hand, these garments physically appear as any 'normal' garment, and through a smartphone screen the green and blue hues in the fabrics can be composited live with videos. To do this we used the same smartphone chroma-key apps used in Greenscreen Dress. For Phem, the speculative aspect is subdued by seeing the animated fabric in front of us and asking "How can this become fashion?". By committing ourselves to 'doing fashion' and nothing else, the expressive potential of the technology becomes valued over all other things. This means less examination of the practicalities of wearing the garments, and more on the pursuits of Phem as a supplemental layer of meaning on top of the clothing–supported by the whole ecology of the things we made such as photographs, jewelry, fabric samples, a logo, digital shimmers, a designer interview, and fashion film.

To clarify, we postulate that in 'doing fashion' for Phem, expressivity becomes our guiding concern. As such, this approach seeks to understand the surface-changing garments in relation to strategies

of and priorities used in fashion. This includes exploring the expressivity of the new material in an open-ended way and ways that relate to clothing craft techniques, to acknowledge the heritage of materials at hand, to work with references that extend from of the dialogue of a particular community, and to generally construct an ecology of things that relate to each other in implicit or explicit ways. In the following section we describe details from the Phem design process that includes making clothing, designing and activating the 'digital shimmers', planning, filming and editing the Phem fashion film in order to demonstrate this fashion-centric approach.



**Figure 2.** Polaroid photograagh that features laser-cut heatpress appliqué on shirt in faux metallic snakeskin. Photo: Angella Mackey

## Phem
### The initial brand concept

Broadly speaking, Phem was conceived to be directed at women in their thirties, to be feminine and sophisticated, and inspired by a "Scandinavian minimalist" aesthetic observed in some popular Swedish fashion brands. We compiled a moodboard of existing garments to reflect this on Pinterest that visualized these themes, and depicted a range of simple, loose-fitting silhouettes and fabrics with soft, solid colour palettes. We made garment illustrations and sourced fabrics, editing the choices frequently. Through an iterative process, the minimalist feel we originally envisioned became overtaken by more colourfully decorated fabrics, yet remained present in the simple forms and silhouettes of the garments. We added to our moodboard inspirational fabric prints and material embellishments to reflect this change.

In parallel, we began envisioning how the clothing would be depicted in the fashion film. We observed many fashion films from fashion brands and designers that spoke to the same sophistication we hoped to achieve. We became inspired by the slow pacing of a Gucci film (Sigismondi, 2016) that rendered mundane things like sitting and looking, walking and daydreaming into whimsical aesthetic experiences. Similarly, we gravitated to many films by the fashion brand COS (hehehe, 2015; HART + LËSHKINA, 2016) that had a similar effect but with less colour and cleaner lines.

We aimed to depict the model in our film doing everyday tasks that were uncomplicated, but to mix this everyday-ness with a surreal mood. Towards this end, we shot in the empty rooms of an old house amongst vintage props and outdoors in the surrounding ru-



**Figure 3.** Phem clothing: Features top and skirt with fabric printed with color-halftone effects. Photo: Angella Mackey
Model: Anne Forceville

Everything was stylized to project softness and femininity (Figure 9). Props and details of the house included four pairs of vintage shoes from a secondhand shop, a beige ceramic coffee mug and urn, a seafoam-coloured metal fan, a sixties beige laminex kitchen table and chairs, diamond-crossed windows with old-fashioned latches, and more. There were five settings that depicted six scenes. The model would be seen doing the following actions: walking up and down the stairs, standing in the front doorway of the house, washing her hands, looking in the mirror, opening and closing a window, putting on pantyhose, pouring coffee, reading a newspaper, and walking through a field of tall golden-coloured grass. Furthermore, we chose to accompany the film with soft piano music by Julien Marchal that held audible artefacts of the piano keys and peddles creaking in the recording as a way to complement the mood and include an old piano as a prop without it being physically present.
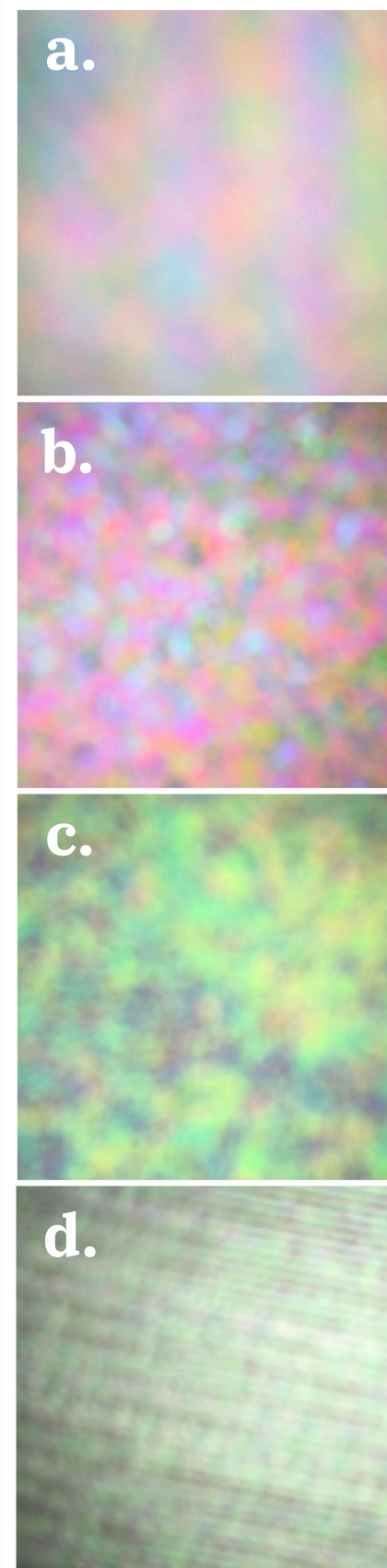


**Figure 4a,b,c,d.** Stills depicting the animated motifs, or digital shimmers
Photo: Angella Mackey

### Identifying and distilling the digital expressivity

From the previous Greenscreen Dress study, we were familiar with the many options for digital animations that could be "worn" on the garments. We had tested graphical patterns like polka-dots and stripes, videos of things such as rain and a mechanical toy bunny, colourful abstract animations at various speeds and compositions, imagery from our surroundings like the passing landscapes viewed from a train and pink bubble wrap on our desk, as well as distorted and pixelated videos using the chroma-key app in unintended ways (Mackey *et al.*, 2017a; Mackey *et al.*, 2017b). Many of these experiments were presented on Instagram and gathered niche sets of followers. Of those, we were most interested in the items tagged with #spacesynth and #glitchfashion, which attracted followers interested in similarly named and related tags such as #glitchart, #synthwave, #mixedreality, #digitalcollage, #spaceart, #abstract, #electric, #newmedia and #spaceambient.

These kinds of tags and tag collections placed under Instagram images shared similar qualities and characteristics. Collectively they spoke of a genre of uniquely computational aesthetics, whereby artefacts of the computer screen and errors in code generated distortions that were considered accidentally beautiful. This is 'glitch art', and has been described in a glitch art context as making "video malleable" (Ram, 2012) alluding to a kind of materiality generated from the digital tools. The #spacesynth tag built on top of this, relating to a retro-futuristic aesthetic. In this context the aesthetic draws from eighties and nineties tastes for neon pinks and blues, ambient electronic music, space-like backdrops, and a "softer" computer aesthetic qualified by curved lines and soft glowing lights in comparison to the more graphical and pixelated glitch art.

Recognising the meeting points of these descriptions, we drew inspiration from them for Phem. As we were still developing our own internal terminologies surrounding what we were making, first referring to the videos on the garments as *dynamic* or *digital fabric*, then *digital patterns*, and next *digital-* or *animated- motifs*, it made sense for us to be thinking of the computer in terms of its materiality and seeking byproducts from the computer screen as a form of digital expression, like glitch art. We tied this to the imaginary world surrounding 'space synth', drawing from its softness and lineage to holographic colour schemes that foreground soft rainbow hues. We drew from this softness to project a mood of femininity. All of this, resulted in collections of abstract video animations for Phem which we settled on referring to as *digital shimmers*. Most had pink and pastel, rainbow-like colour palettes, some with black and silver included, and all moved and changed in sporadic ways that reminded us of sparkling fabrics (Figure 4a, b, c, d). We made them by capturing glitch-like imagery from the computer screen. The change in terminology that we used when making these animations was significant, suggesting a shift in perspective from designing objective things (fabric, patterns or motifs) to articulating their dynamic quality, that of 'shimmers'.

### Strict editing process that values unity of the expressive concept over effect
In our previous explorations with green materials and a chroma-key app (Mackey *et al.* 2017a; Mackey *et al.*, 2017b), we learned that fabric qualities other than an exact chroma-green (the bright green that the app was programmed to seek) would affect how the digital shimmers appeared through the garments.

For example, if we chose a smooth fabric that was chroma-green, the fabric itself would disappear and become entirely replaced by the video or image. Instead, if we used a green fabric with a different shade, with noticeable textures, or with some sheerness, the results would blend with these qualities, for example, by maintaining the sheerness.  This presented opportunities to explore how the digital shimmers and physical materials could expressively intertwine–having the digital be reflected through the physical and vice versa without losing either one. For this reason, we made garments and accessories that used many kinds of fabrics and materials, including heavy woven and quilted fabrics, sheer silks, large plastic sequins, many light and dark shades of green and blue, laser-cut fluorescent acrylic materials, artificial green metallic snakeskin (Figure 2), and stretch jerseys.

We also experimented with designing custom printed fabrics and laser-cut shapes from various materials to further explore our control over the output. We did many tests, producing prints that combined large pieces and bits of all the possible chroma-key colours, that of green, blue and pink (Figure 5). We laser cut acrylic jewellery and circle shapes with "glitch-like" distortions for appliquéing onto fabric (Figure 2). The most surprising results came from a series of prints we designed that used colour halftone effects in Adobe Illustrator CS. It worked as a colour separation technique that reduced solid colours to gradients of dots in different sizes (Figure 6a, Figure 7). Looking at them on the computer screen, we thought they suited the brand concept well. When they were printed as physical fabrics however, they surprised us in other ways. Firstly, they confused the smartphone camera. The colours were perceived differently up close versus far away, meaning, the app would composite them with shimmers at far distances, but not when the camera moved close. Secondly, some of the colour halftone prints created a shimmering moiré effect when seen in the physical form. The effect reminded us of computer screen moirés effects we had been sampling to produce the digital shimmers in the first place. Thematically, the color-halftone patterns created a cohesion for Phem.

These material explorations resulted in the construction of nine garments with custom-printed fabrics, two garments with heat-press appliqué, one garment with sequins embellishment, five garments made from other textured and sheer fabrics, and multiple pieces of jewellery using plastics and acrylics. We hoped to include as many different kinds of materials as possible so as to show off the unique effects of the chroma-key app with corresponding materials. We compiled a list of effects entitled "The catalogue of digital effects", that described them and listed even more effects we hoped to pursue. However, trying to include them in this way began to blur the Phem brand vision. The unity we aimed for became muddled by trying to push Phem's voice through "effects". It was decided to heavily edit down the garment selection to only ones that related to each other. This included cutting out some of the garments with the most interesting colour halftone effects, but also adding new ones to "join" the ones that remained. We did this by scanning fabrics from two coats and derived new colour halftone prints from their core patterning (Figure 6a,b), as well as embellished a sheer nude-coloured fabric with large pastel-coloured sequins that related both to the characteristics of the digital shimmers and the dots within the colour halftones patterns.

To summarise, we experimented with many materials and techniques

for controlling the translation of the digital shimmers through the fabrics, and the fabrics through the shimmers. The final garments that were chosen for the film were ones that referenced each other, and particularly those that reflected qualities found in the digital shimmers. This included themes from holographic colour palettes, computer screen artefacts, and circle shapes. The final film presented four garments with colour-halftone prints (Figure 3), one laser-cut "glitched" circle appliquéd onto a jumper (Figure 2), and a shirt embellished with circle-shaped sequins (Figure 10).






**b.**
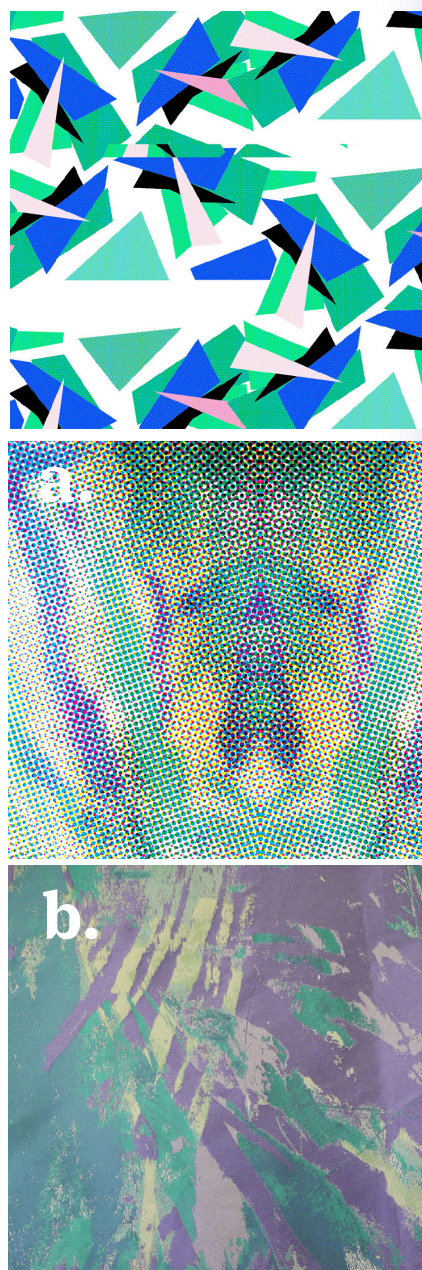
### Styling the digital shimmers through the pace and context of the fashion film

This final design activity explicitly draws from our "pre-digital" fashion knowledge, relating to how the digital shimmers were reminiscent of sparkling fabrics and materials. Sparkling embellishments such as sequins have a rich history in fashion, going as far back as Tutankhamun ("King Tut") whose garments were found embellished with gold sequin-like discs (Spivack, 2012), likely some form of coin. Generally, sparkling materials like sequins were a sign of wealth and nobility, and as they became more readily available in the 20th century their symbolism transformed into varying degrees of enchantment, elegance and glamour. Herbert Lieberman was the first to make sequins from film-stock acetate in the late nineteen-thirties, and said "The light would penetrate through the colour, hit the silver, and reflect back…Like you painted a mirror with nail polish." (McCormack, 2005; Spivack, 2012)

Designing and styling with sequins, and other reflective materials, requires tuning to past and contemporary cultural understandings of their effects, whether this is learned explicitly or tacitly engrained through experience. Considering the social contexts that they are worn, and how they are worn, can affect the degree to which they can be used to distract, dominate or allure onlookers. This threshold, between being perceived as overly ostentatious or fortuitously enchanting, is a balancing act a fashion designer or stylist navigates when working with sparkling materials. For Phem, we activated the digital shimmers with these thresholds in mind, seeing them and working with them as expressive extensions of shimmering materials. We aimed to have them appear fortuitous, presenting the model as passive and not explicitly in control of their occurrence.

Still, the digital shimmers are virtual and do not behave like physical shimmering or shiny materials. They are not activated by light or the movements of their wearer. So, styling them required special conditions which we found in the film format. If sparkling fabrics can be considered dynamic or surface-changing, then in comparison the digital shimmers are hyper-dynamic¬ by being in motion constantly, at varying speeds and rhythms, and not fixed in a real time or a physical space. Objectively they sit in an image folder on our smartphone and despite testing them on the garments at our studio, we did not confidently know how they would be worn as garments. The film offered a platform for us to experiment with placing them (Figure 8a, b, c), helping us answer questions for *when? where?* and *how?* they should they be styled. In a way, the film allowed us to fix them in time and in a space where previously they existed in a space of potentiality. With the context that the film provided–a person, garments, setting, activities and a linear timeline–the moving shimmers came into existence. Styling this included balancing semantic readings for the contextual whole of each scene, including the vintage feel, as well as compositional elements including colour, line, texture, light and shadow. This meant discovering which shimmers truly "worked" with each garment in each space. Considering the temporal form of the digital shimmers, the fashion film provided a place for them to "play-out"

and allowed us to transform the shimmers into "fashion" in ways not possible throughout our explorations in a studio or by documenting their effects.

When the film was finished, we felt we had achieved the right balance and that the shimmers had come to life. They appeared and disappeared in their own unique way, which was different from traditional sparkling fabrics yet somehow an extension of their lineage and effect. As hybrid, surface-changing garments we brought together two expressive forms, that of clothing and digital phenomena, contextualizing and unifying them through the Phem brand concept.
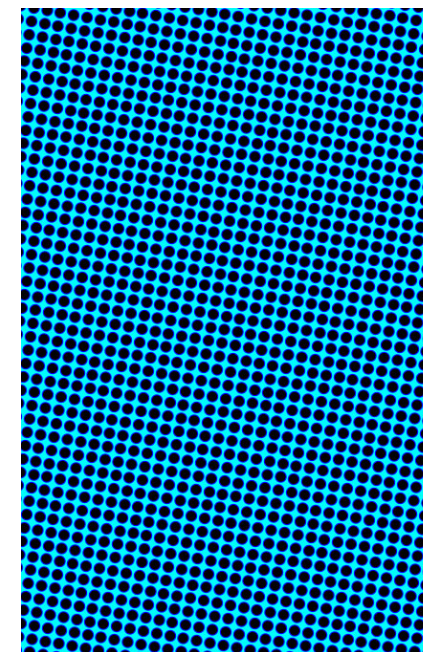


**Figure 7.** Colour halftone effect that has a moiré effect. Photo: Angella Mackey

**Figure 5.** Printed fabric for testing.
**Figure 6a.** Colour halftone print derived from fabric used for purple coat.
**Figure 6b.** Fabric used for purple coat.
Photos: Angella Mackey

**Figure 8a, b, c.** Screenshots from Phem fashion film depicting the digital shimmers in action.
Photo: Angella Mackey

## Summary and Contributions

As we hope to have demonstrated throughout this description of Phem, there is value in approaching clothing-based dynamic materials from a fashion-centric perspective. In using expressivity as a guiding concern, and a fashion brand concept as the boundaries of this expressivity, the emerging technology became part of a dialogue broader than itself as a singularly designed object. Phem draws inspiration from contemporary fashion brands, and thus takes cues aesthetically from contemporary sources that exude sophistication and femininity. By styling it amongst everyday activities and vintage settings it became relatable but at the same time surreal enough for it to be considered fashion. By drawing from Instagram communities related to the tags #spacesynth and #glitchfashion, it extended an existing dialogue surrounding an imaginary world and aesthetics drawn from glitch art. By using screen distortions to create the shimmers and fabric prints, the virtual and physical forms of the garments related to each other in multifaceted ways. By styling the digital shimmers as if they were sequins, we built on top of the heritage of sparkling materials. And finally, the threads that tie each of these details together were able to play out cohesively in the fashion film, acting as an articulation device for the imagery we hoped to attach to the clothing, and for it to become fashion.

## Discussion
### Setting up the conditions to challenge wearable technology characterizations
As described earlier, we have observed the wearable technology discipline to be characterized by science fiction, futuristic or sports-related aesthetics. While this is not a problem per se, it creates an opportunity to explore something different, one that deliberately steers away from this tendency. For designers who wish to bring technology closer to everyday dress, this strategy could be beneficial. To further demonstrate this, in 2013 after a year of Google Glass being criticized in the media for its lack of style (e.g. Honan, 2013), Vogue magazine featured it in a twelve-page spread called "The Final Frontier" (Vogue, 2013). It presented models wearing Oscar de la Renta and Gucci with the glasses against dystopic landscapes and space-like architecture. Although indeed the references are futuristic, they are heavily blended with vintage-style haircuts, accessories, garment silhouettes, wool textures, colours, props and materials from as far back as the 1930s up until the early 2000s. Furthermore, the glasses themselves almost disappear in each depiction, making the focus of the photoshoot the entire outfits and construction of the imaginary world and the people in it–a bigger picture than the device. Presenting wearables as fashion in a fashion context can be very persuasive in shedding the 'gadget-ness' perspective that tech companies often put forth. Similarly, approaches to wearables that draw from a contemporary fashion dialogue and consider the ways technology can work to extend fashion expressivity, might function to draw wearables out of its niche existence and closer to everyday dress.

For Phem, we wanted to create a setting that would enable us to navigate this possibility. This meant deliberately avoiding filming the garments in isolation (e.g. a white studio backdrop) or in a setting that said "the future" or "technology". We aimed to explore and understand the notion of surface-changing garments through their relations to everything else, exploring different arrangements of







**Figure 9 (collection)** Polaroid photographs from film shoot.
Photo: Angella Mackey

things next to things. There were specific questions we had in the beginning of our process based on our experiences with wearables, that we sought to resolve throughout this process, which helped us to see more clearly the technology's potential as fashion. For example, we wondered, could the digital aesthetics of the clothing be used to express femininity when technology is so often perceived as masculine? Is it possible to depict technology without saying "the future"? How would the animated fabrics work being set next to everyday activities such as pouring coffee? And, considering Greenscreen Dress only depicted garments in 6-12 second Instagram video clips, how would they be worn over longer stretches of time? As fashion media are designed to prioritize expressivity and be referential to fashion history or contemporary cultural phenomena, filtering wearables through this lens naturally extracted a vision more closely connected the ecology of everyday dress. Furthermore, choosing to use the fashion film as an end goal provided a platform that allowed us to explore aesthetic arrangements for AR-enabled surface-changing fabrics, well before such fabrics have been made easily accessible or commonplace to fashion designers.

**Exploration of a technology through it relations to other things**
In the work preceding Phem, we confronted speculations about dynamic, surface-changing fabrics through the day-to-day lived experience of it. Here, we were able to examine how this fabric created shifts in our personal experiences with clothing, how it made us feel, how it affected the people around us and much more (Mackey *et al.*, 2017a; Mackey *et al.*, 2017b). This exploration was open-ended and resulted in a series of reflections, skills and knowledge surrounding dynamic fabrics. We described a moving "beyond speculation" due to the real and presently-existing variables of a genuine context, writing ' ... we focus on how the activity of wearing an approximation of dynamic fabric in everyday life combined with design activities can bring speculative explorations of dynamic fabric into day-to-day living. What we mean by this is that the inquiry is moved into a space where an extended time period, situated audience and genuine social context become variables. These variables, in turn, allow us to challenge previous assumptions or speculations, observe new opportunities that emerge, and place a genuine socio-cultural perspective at the center of the discussion.' (Mackey *et al.*, 2017a) Phem builds upon the skills and knowledge gained from Greenscreen Dress, but also its methodological core. In order to explore how dynamic materials can blend with everyday dress, it too immerses this concept in a genuine context, that of genuinely building the look and feel of a fashion brand identity and giving it a broader function through fashion.

Yet this new goal made the journey entirely different. It was less forgiving than the open-ended explorations of Greenscreen Dress. It called for the precision of design where more attention was given to the connections made between the designed artefacts, the heritage of the materials that construct them, the imaginary world surrounding them, their place in the existing world, and the communication of all of this to an audience. By creating Phem, the notion of surface-changing fabric is formed through its distillation in the fashion design process where expressivity and reference are prioritized over all other things. In other words, the clutter of Greenscreen Dress was cleared away so that Phem could build a unity from all the things chosen to surround it. As John Dewey (1934) writes, 'It is significant that the word "design" has a double meaning. It signifies purpose and

it signifies arrangement, mode of composition. The design of a house is the plan upon which it is constructed to serve the purposes of those who live in it. The design of a painting or novel is the arrangement of its elements by means of which it becomes an expressive unity in direct perception. In both cases, there is an ordered relation of many constituent elements. The characteristic of artistic design is the intimacy of the relations that hold parts together.' (1934)

If the purpose of design is to take tools, materials, or ideas, transform them and make sense of them for a broader group of people, then this is how Phem acted as the next step of the Greenscreen Dress study. It moved the exploration of dynamic, animated fabrics from its relationship to the thoughts, feelings, and contexts of one person's life, to an exploration of its relationship to a broader cultural dialogue already taking place in fashion.

**Future Work**
The next step of Phem will be to present the selected artefacts collected or made during this study to an online audience: the moodboard, fashion illustrations, fabric samples, collections of digital shimmers, clothing, jewellery, logo, video of an interview with the designer, digital photographs, Polaroid photographs, and the final fashion film. All of these artefacts attempt to speak to each other, entangling the same aesthetics, and drawing from the same aesthetic sources. By way of social media such as Instagram, Pinterest, Vimeo, and Facebook, we will attempt to build an appreciative audience for Phem and reflect on this next step of its transformation.



Figure 10. Sequins embellished top.
Photo: Angella Mackey
Model: Anne Forceville

**Conclusion**
In this paper, we discuss technology-centric approaches to the field of wearables, and how fashion can be used strategically to deflect this. We describe how fashion adds a layer of meaning onto clothing, and how the fashion film can be used to specifically explore materials with a temporal form. We describe the Phem design process which includes conceptualizing the brand, identifying and distilling the digital expressivity, implementing a strict editing process that values unity of concept over effects, and styling the digital shimmers through the pace of the fashion film. Finally, we conclude with a discussion for how this work can be valuable to wearables designers, and reflect on our RtD approach which aims to explore an emerging technology via its relations to other things.

# References

Arthur, R. (2016) Hololens' Mixed Reality To Transform London Fashion Week Show, Forbes. Available at: https://www.forbes.com/sites/rachelarthur/2016/09/16/hololens-london-fashion-week/ (Accessed: 18 October 2018).

Berglin, L. (2013) Smart Textiles and Wearable Technology - A study of smart textiles in fashion and clothing. A report within the Baltic Fashion Project. Borås, Sweden: Swedish School of Textiles, University of Borås. Available at: http://www.diva-portal.org/smash/record.jsf?pid=diva2:884011 (Accessed: 21 September 2016).

Dewey, J. (1934) Art as experience. New York: Minton, Balch & Company.

Dunne, L. (2010) 'Smart Clothing in Practice: Key Design Barriers to Commercialization', Fashion Practice: The Journal of Design, Creative Process & the Fashion Industry, 2(1), pp. 41–66. doi: 10.2752/175693810X12640026716393.

HART + LËSHKINA (2016) COS + Agnes Martin | Guggenheim 2016. Available at: https://vimeo.com/185292456.

hehehe (2015) COS Urban Landscape by Andr&eacute; Fu. Available at: https://vimeo.com/122943996.

Honan, M. (2013) I, Glasshole: My Year With Google Glass, WIRED. Available at: http://www.wired.com/2013/12/glasshole/ (Accessed: 13 April 2015).

Loschek, I. (2009) When Clothes Become Fashion: Design and Innovation Systems. Berg.

Mackey, A., Wakkary, R., Wensveen, S. and Tomico, O. (2017) '"Can I Wear This?" Blending Clothing and Digital Expression by Wearing Dynamic Fabric.', International Journal of Design, 11(3).

Mackey, A., Wakkary, R., Wensveen, S., Tomico, O., Hengeveld, B. (2017) 'Day-to-Day Speculation: Designing and Wearing Dynamic Fabric', in Proceedings of the 2017 RTD Conference on Research Through Design. Research Through Design, Edinburgh, Scotland, pp. 439–454. doi: 10.6084/m9.figshare.4747018.v1.

Manovich, L., Malina, R. F. and Cubitt, S. (2001) The language of new media. MIT press.

McCormack, D. (2005) 'Spangle is a Synonym for Sequin', 9 November. Available at: http://thefanzine.com/spangle-is-a-synonym-for-sequin-2/ (Accessed: 18 October 2018).

Normals (2012) A P P A R E L. Available at: http://normalfutu.re/apparel/a-p-p-a-r-e-l-v-1-0-project-page/ (Accessed: 20 October 2016).

Ram, A. (2012) 'The Rise of the Glitch: How Broken Technology Became Art - The Atlantic'. Available at: https://www.theatlantic.com/video/index/260992/the-rise-of-the-glitch-how-broken-technology-became-art/ (Accessed: 18 October 2018).

Ryan, S. E. (2014) Garments of Paradise: Wearable Discourse in the Digital Age. Cambridge, Massachusetts: The MIT Press.

Schön, D. A. (1992) 'Designing as reflective conversation with the materials of a design situation', Research in Engineering Design, 3(3), pp. 131–147. doi: 10.1007/BF01580516.

Seymour, S. (2008) Fashionable technology: The intersection of design, fashion, science, and technology. Springer Publishing Company, Incorporated

Sigismondi, F. (2016) GUCCI - Garden. Available at: https://vimeo.com/192630295 (Accessed: 18 October 2018).

Spivack, E. (2012) 'A History of Sequins from King Tut to the King of Pop', Smithsonian, 28 December. Available at: https://www.smithsonianmag.com/arts-culture/a-history-of-sequins-from-king-tut-to-the-king-of-pop-8035/ (Accessed: 18 October 2018).

Stoppa, M. and Chiolerio, A. (2014) 'Wearable Electronics and Smart Textiles: A Critical Review', Sensors (Basel, Switzerland), 14(7), pp. 11957–11992. doi: 10.3390/s140711957.

Toussaint, L. (2018) 'Wearing technology: When fashion and technology entwine'.

Uhlirova, M. (2013) '100 Years of the Fashion Film: Frameworks and Histories', Fashion Theory: The Journal of Dress, Body & Culture, 17, pp. 137–158.

Vallgårda, A. et al. (2015) 'Temporal form in interaction design', International Journal of Design, 9(3), pp. 1–15.

Vogue (2013) The Final Frontier – Photos – Vogue - Vogue. Available at: https://www.vogue.com/slideshow/the-final-frontier-photos (Accessed: 18 October 2018).

Weinmans, M. and AugmentNL (2013) 'Wearable augmented reality'. Amsterdam Fashion Week, Netherlands, January. Available at: http://augmentnl.com/hyperfabric/ (Accessed: 20 October 2016).