

# Fashionable Shape Switching – Explorations in Outfit-Centric Design

Oskar Juhlin<sup>†</sup>, Yanqing Zhang<sup>†</sup>, Cristine Sundbom<sup>†</sup>, Ylva Fernaeus<sup>‡</sup>

<sup>†</sup> Mobile Life @ Stockholm University  
Kistagången 16, Kista, Sweden  
{oskar, celia}@mobilelifecentre.org

<sup>‡</sup> Mobile Life @ KTH  
KTH, Stockholm  
fernaeus@kth.se

## ABSTRACT

We present a design exercise illustrating how fashion practices and the fashion design process can be used to create new opportunities both in the mobile domain and in product design, as well as in wearable computing. We investigate the concept of outfit-centric design by extending the support for social and visual interaction with digital devices beyond the currently available shells and stickers, and drawing on the ways in which people vary their dress ensembles. We designed a set of mock-up samples in a local fashion style, as a first step in understanding possible applications of the emerging technology of organic interfaces. Initial user feedback shows how fashion-conscious participants creatively experimented with the set's variations of shape and color in outfits created from their personal wardrobes, which revealed the importance of the objects' size and location on the body. It also points out that a lack of integration with the fashion system's processes reduces the attractiveness of the samples.

## Author Keywords

Fashion; outfit; design; mobile interaction; product design; wearable computing; organic interface; dressing

## ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## General Terms

Human Factors

## INTRODUCTION

The relationship between product design, interaction design, and fashion is currently attracting increased attention among researchers in HCI, for instance in studies of

fashion in online gaming [4], sustainable fashion design [23], wearable computing [27], and mobile design [16]. Fashion studies [19, 31], which focus on both the aesthetics and social characteristics of clothes, is particularly relevant to product design [26], which increasingly deals with material properties of digital devices close to our bodies [31]. Hardware design is growing along with the increasing availability of microcontrollers in everyday products [7]. In particular, wearable computing research has revealed challenges in developing solutions that become an accepted part of daily clothing practices. There are many fully developed products showing potential from the utility part that for various reasons have yet to become commercially viable, for example, smart sportswear, socially connected T-shirts and party dresses equipped with light displays [27]. Opportunities still remain to design interactive products within an established “ecosystem” such as that of fashion. Here it is important to bridge industrial and interaction design to create devices with meaningful relations between the appearances of the device and other desirable objects. We also see similar concerns in the emerging area of organic interfaces, which still need more applications [29].

In mobile interaction design, there have been explicit attempts to create designs that target a fashion-conscious market, i.e. people who are interested in their physical attractiveness and image [30]. The industry has provided accessories and hardware designed for them, and has marketed devices on fashion runways and in fashion magazines. A recent study of fashion bloggers' comments about mobile phones [16] shows that more opportunities can be found in this area by learning from fashion-conscious people's practices. The posts show apparently that they appreciate public visual aesthetics, accessories that combine with an outfit to create a look, and variation of looks. The limited number of posts that discuss mobile phones was explained as possibly due to mobile phones' limited uses as accessories in this sense. The opportunities to create and vary visual aesthetics on smartphones are restricted to the screen, which is normally turned towards

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the user and invisible to people nearby. On the other hand, the back of a device offers a look that cannot be altered, unless by adding a cover. Again, it is the other way around when it comes to other fashion objects. Garments and accessories are easily combined to create publicly visible codes transmitting messages to surrounding people [11]. The study [16] points to the possibility to design interfaces (outfit-centric design) that extend social and visual interaction and the way people vary their outfits and dress ensembles beyond the current decorations.

The design exercise presented here investigates how to account for methods used by fashion to create items that people adore [19] e.g. how a garment becomes fashion when it is integrated within an institutional system including designer cults and design by style. This resulted in the concept of a shape-switching digital device, whose shape could be changed when selecting a new dressed ensemble. It was presented as a series of 22 mock-up samples that are in themselves hard to the touch (Fig. 2), which vary in color and shape. Importantly, this is a step prior to exploring the actual shape-switching device, in which we would focus more on digital functionality and usability issues. The concept was inspired by the opportunities emerging with organic interfaces [29], where the interface is conceived as capable of transforming into a variety of shapes, either by manual selection or by some sort of automatic feature. The set is designed based on studies of fashion-conscious people in Stockholm, emphasizing fashion as a local and historically dependent phenomena [see e.g. 9]. The shapes are visible both to their owner and to people in the vicinity. The making of prêt-à-porter samples by a designer is important since it accounts for the fashion design process. We gathered initial user feedback from five users who mostly participated in their homes by experimenting with selecting among the samples to see how they fit with the ensembles from their wardrobes.

## RELATED WORK

This study is influenced by fashion theory and research investigating how product and interaction design uses fashion as a strategy in mobile industry.

### Creating Fashion Versus Producing Clothes

The embedding of electronics into items of clothing has been investigated in both research and industry for many years. The term “fashionable wearables” is sometimes used to refer to designed garments, accessories, or jewelry that combine aesthetics and style with functional technology [27], e.g. smart clothes like the “Know Where Jacket,” which incorporates GPS technology, and the “Life Shirt” which measures health [20]. It is a recognized challenge to develop solutions that are accepted into everyday clothing practices and thereby stand a chance of becoming commercially viable. Some of the difficulties could be traced to the core challenge of designing interactive products to fit in an already established “eco system” of cloth-

ing practices, including issues of matching, presenting identity and cultural belonging.

Fashion is an important driver of taste and it constantly molds ideas of what is considered beautiful [19, 31]. Wilson says the changing perception of what is fashionable has to do with the evolution of aesthetic style, reflecting ambiguities and dissonances in society [31]. It is important to recognize that fashion is not the clothes themselves, but the social institutions and practices that make garments fashionable [19]. Among the social institutions, our study focuses on designer and style [19]

Similarly, the shifting trends in the visual appearances of electronic devices can be discussed using notions from fashion theory. This may especially apply to personal mobile devices, which are carried in close proximity to one’s body. In this respect, mobile phone could be conceptualized as fashion statement, a theme explored in several sociological studies [10, 18]. In HCI literature, Pan et al. [23] discuss how people have reported sometimes feeling social pressure to invest in a device in order to fit into a group. Thus, as with the formation of local dressing practices, these devices become markers of a shared (sub)cultural identity. For new products to count as “fashion” would therefore involve more than the researchers agreeing that it is “pretty” or well-crafted. Instead the design has to connect to fashion practice and find legitimization through fashion mechanisms. This involves not only an appreciation of the object, but also how it fits into a person’s visual presentation, as part of a social setting where appearances count. In this paper, we address this theme by exploring mobile interaction design in a way influenced by fashion approaches.

### Fashion in Mobile Hardware Design

Fashion design of mobile phones has mostly concerned hardware, e.g. the selection of colors, shapes, and materials used for different handsets, or the marketing of different phones to specific user groups. Also luxury phones, made of precious materials such as crystal and gold, have been appearing since the beginning of this century. Other materials such as leather and fabric, often seen in fashion, have been used, e.g. the Nokia L’Amour Collection [35]. Before the advent of touch-screen phones, they also displayed co-branding with fashion companies or designers [13], such as Prada phones (LG).

The most visible way in which the mobile industry has approached fashion has been through cases, charms, stickers, shells, and other decorations [10, 18]. Nokia popularized changeable cases on mobile devices in the 1990s [8] and other manufacturers, e.g. Sony Ericsson, followed suit releasing fashion phones. Attaching personal charms to mobile handsets remained popular for a long time, especially in Asia, but has now almost disappeared, partly because some mobile phone brands have ceased providing means to attach things. Today, many fashion brands start to design and sell their mobile cases and shells.

In product and interaction design, visual style is considered important for generating user experiences, along with temporal and sensual features, i.e. how it feels to press a button and what manual actions one can perform. The importance of these aspects is especially visible in the field of tangible, embedded and embodied interaction. One specific research that is becoming increasingly relevant is the embedding of electronics in new physical materials, such as soft textile sensors [25] and shape-shifting [29], foldable [22] organic interfaces [29]. One example from mobile design is Nokia's Morph concept that explored emerging "bendable interfaces" such as bracelets a few years ago [34]. Since electronic product design has mostly concerned with designs using hard materials, these types of experiments point to both new opportunities and challenges. Fashion is a valuable source of inspiration as it is one of only a few domains with long-established traditions of using soft materials in design. In this paper, we will explore aspects of soft hardware in mobile interaction design that takes fashion and dressing practice as its starting point.

### Fashion in Mobile Interaction Design

Alongside hardware design, there is a wide range of software and services, usually in the form of apps for smartphones, to assist fashion-conscious people in selecting clothes to wear. In a recent overview, thirty-three such apps were found [16], e.g. the fashion camera, the mobile closet, and do-it-yourself fashion design.

Kashanipour [16] (Fig. 1) presents a first attempt to apply the outfit-centric concept using contemporary smartphone technology. Figure 1a shows how a user can take a photo of a detailed pattern on her clothes and use it as the background of the screen, to match the phone with the dress ensemble. This specific action could easily be performed with the standard software of any smartphone, but an application that specifically promotes this use might lead a fashion-conscious person to treat the phone as part of a dress ensemble. Figure 1b shows the pattern from the dress printed on a sticker attached to the back of the phone. This illustrates the important difference between personal expressions displayed on the screen of a mobile device, and the public appearance of its back. This app



Figure 1 a and b: Kashanipour's Matching Application

differs from other available ones by inviting users to make the phone part of his/her outfit, rather than a tool for making an outfit. Another project, Mobile ActDresses [14], attempts to connect the physical look of a mobile phone with its digital contents. When the user shifts between physical shells adorned with different designs, the phone software automatically shifts between preset configurations, e.g. playlists and background themes. These designs are all limited by existing standard hardware. Our study aims at looking more closely at the potential visual features of novel physical interactive products in relation to personal outfit.

### DESIGN PROCESS

The studies presented here also explore the Outfit-centric design. It includes pre-studies on dressing practices and an aesthetic experiment (using a method described in [1]) that moved beyond current hardware constraints and resulted in an analysis of local fashion style and a set of 22 mock-up samples respectively.

### Study of Dressing Practices

Woodward [32] analyzes dressing practice around wardrobe and its contribution to build women's self identity through ethnographic studies. Unlike it, we aim to unpack "how" the practices are conducted instead of "why". Just as Wilson [31] describes: "*Getting dressed...is a matter of bricolage. A finished appearance is a combination of the coming together of garments and accessories that we have usually not made ourselves*".

In order to understand the outfits in fashion and thereby further ground the design in fashion-conscious people's practices, we interviewed four persons, three of whom were female, about how they put together their dress ensembles. The participants were recommended by friends of researchers as being "stylish." The interviews with the females were held at their homes, while the male preferred to be interviewed at his office. We focused on how they select items from their wardrobes and combine them into an ensemble. An interviewee said "*Normally, since the pants I often wear to work are either black or khaki... so if they are black, it's easy, almost any color and style will match. If I wear khaki pants, then I will go for some plain color and earth tone clothes, or similar brown tones. So it's not that difficult to match.*" Other interviewees started off with an idea of a particular style, such as the 1960s, a celebrity, a specific item such as a dress or a top, or a color tone. The matching rules, and the order in which the items are selected, vary a lot depending on where the clothes are going to be worn, personal taste, and what clothes are available in the wardrobe.

Putting together an outfit was a very practical activity, often done in the evening, and included taking clothes out of the wardrobe, juxtaposing them, and then getting a visual overview of the ensemble. An interviewee said that she would "*...take them out and fold them up and see whether the colors clash. I don't put them on.*" Another

interviewee said “*I must take them out and try them on in front of a mirror.*” The man always started with items such as shirt and pants, which were put on a chair for inspection.

To sum up, we learned that the interviewees do spend time matching items into variations of outfits. It also shows that matching is a demanding activity highly focused on visual presentation. Each item is selected based on e.g. other items selected, making the final result of a dressed ensemble.

### Selection of Ways of Matching

Outfit-centric design suggests that the visual appearance of the device should match the outfit. However, how this matching should be achieved remains an open question. In Kashanipour’s exercise [17], she suggested a method, which we term “manual matching,” that gives users an infinite number of possibilities to change the appearance of the screen. In our case, the interaction is imagined to be provided by an organic interface, which might also give an infinite number of possibilities for switching shapes. Still, we decided to provide only a limited number of shapes. This mechanism is aligned with fashion logics [19], i.e. draws on a finite number of possibilities for switching in between shapes. The designer’s expertise therefore plays a specific role in this exploration: to investigate a matching mechanism that restricts users’ possibilities, following the tradition in fashion where people buy

prêt-à-porter [21] from stores, instead of making clothes themselves [31]. The user gets to choose the appearance of the device from limited options provided by a designer.

### Aesthetic Experiments

The industrial designer was solely responsible for the aesthetic experiments [1], with the goal of creating a concrete instantiation of the concept. Her activities included participation in workshops on the topic “design naturally,” investigations of emerging trends in fashion and design [33], and ideation [14], e.g. through sketching based on close readings of fashion statements by Swedish designers [9]. We decided to imagine a digital device that could change its shape and color- a “shape switcher”. The idea was influenced by envisioning of organic interface, which means recent explorations of computer interfaces that use non-planar interaction surfaces (by deformation either via manipulation or actuation, or both) to interlink with digital activity [29]. The concept was instantiated in 22 shapes, (Fig. 2). The shape variations could occur within four devices (unchanging color) or one device (changing color), but one device per outfit.

### Swedish Style Articulated

These shapes were inspired by fashion aesthetics, where the design of clothes depends on the color of the fabric and the cut and form of the garment. In doing this, the designer had to take not only the outfit-centric concept into account, but also users’ taste. The results might have



Figure 2. The 22 designed shapes of a shape-switching device

been influenced by how the concept in general pleased them, but also by how well the available design options fitted together with their style. Fashion, as it takes concrete form, varies not only in time, but also in geographical locations and different sections of a society. What are considered fashionable outfits will inevitably look different if you study people in Tokyo, Paris, New York, or New Delhi. Since this project was physically conducted in Stockholm, we have specifically analyzed the characteristics of contemporary fashion from a local perspective, i.e. the Swedish style [9]. The style is simple, clean, streamlined, and jeans oriented [9]. It is light and minimalistic and often employs shapes, for instance in the form of drapings, characterizing of Swedish fashion brands (e.g. ACNE). The shape is dominated by sharp cuts and soft drapings, formulating a contrast. The design has clean lines but can be playful in form and cut and may have surprising details [9]. Moreover, this style is characterized by monochrome colors, with most items in grey, black, beige, and denim. Thus, the so-called fashion phones of the late 1990s, with predominantly lots of details and “bling,” can be seen as almost the opposite of the Swedish aesthetic norms.

This style inspired the design of the final mock-ups in Figure 2. They were physically hard to the touch to mimic a static appearance fitting with a specific ensemble. The colors selected are those of Swedish jeans fashion, ranging from black to beige and white. The shapes range from rectangular to organic forms, from sharp cuts to soft draping, and to more playful forms. We use “sample,” which means “the first version of a garment made in real fabric” [28], to refer to the mock-ups.

#### **INITIAL USER FEEDBACK**

To acquire initial user feedback on the samples, we selected five women in their 20s and 30s. Their occupations range from fashion design to project management. The participants were recommended by friends of the authors, and were considered to exemplify the Swedish style. This was also confirmed during the interviews, when looking at the clothes they selected and the brands they wore. The participants were invited to select items from our series of mock-up samples (Fig. 2) and combine them with a series of self-selected dress ensembles based on items from their personal wardrobes. The idea on selecting a single sample for each outfit, was used to explore further the concepts’ grounding in how people vary the visual look of their outfits over time. They were told to pick one at a time, since we imagine the shapes as appearing out of a single device. Four interviews were held at their homes to make the study as realistic as possible. The fifth interview was done at a café, due to her reluctance to show private space. We present an analysis of how they combined the samples with variations of personal outfits, varied the location of samples on the body and selected colors. Finally we discuss users who disliked choosing from a variety of shapes. We use fake names in presenting the interview data.

#### **Selecting Multiple Samples with Variations of Outfits**

Three users chose different samples to combine with different personal outfits: Alice, Table 2 (Outfits 7–10); Klara, Table 3 (Outfits 16–18); and Emma, Tables 2 and 3 (Outfits 11–15). Alice, for example, was asked to select a favorite piece of her own clothing, then an accompanying accessory, and finally one of our samples. She chose a yellow dress (Outfits 7 and 8) that she had been wearing a lot recently. In order to choose the matching accessory, she asked whether it was intended for “the day or evening” but answered herself by creating a look for each occasion. The day look (Outfit 7) was completed with a black leather jacket and Converse shoes. For this outfit she selected a black sample (no. 18), and made it into a necklace hanging on a black ribbon. For the evening look (Outfit 8), the dress was matched by a red-lip bag, necklaces and rings, black high-heel shoes (not shown in this picture), and a black sample (no. 22), which is smaller and more deformed than no. 18. Both Alice and Emma used various samples with different outfits and Klara stated her interests in varying samples with different outfits.

These results reflect the intention of our design concept to change the shape of a device to fit with a person’s variations of the public visual appeal of dress ensembles. But we should also recognize the limitations of the data collected: first, the interview with Klara was done in a café, which then did not allowed here to pick items relative to several outfits. Second, outfit 7,8,9 all include items in bright color or patterns, which are not the most typical Swedish style. But they do include typical Swedish styled items in the outfits, such as Converse shoes and leather jacket.

#### **Variation of Items and Position on the Body**

In the three tables, we can see that all participants selected different locations to put the samples. Alice, Klara, and Emma used the samples as necklaces (Outfits 7, 11, 13, 14, 18), brooches (5, 16), a ring (17), shoelaces (15), a bag (12), and held them in their hands (2, 3, 4, 8, 9, 10). The possibility to change the position of the samples on the body and its importance, were not pre-conceived in the design, and we were surprised by the creativity. It was in a sense made possible by the set-up of the user study, where the clothes, accessories, and designed samples were laid out on a bed. Had they been trying on the clothes, the lack of attachment on the samples probably would have prevented them from experimenting with body locations. Their creative use of the samples shows the importance of providing different ways to attach them to the body. An interesting direction for future work is to explore how organic interfaces could be used to design attachments more fully worn to fit the body, like clothes.

#### **Color Variation**

The participants also used shapes with several colors. Black items were used more often than other colors. Items 16–22 were chosen 11 out of 18 times. White samples were selected five times (Outfits 9, 13, 14, 16, 17) and

variations of brown were selected four times (Outfits 3, 4, 11, 12). Importantly, three of the participants (Maya, Alice, and Emma) varied the colors of the selected sample

with relation to different outfits. For example, Alice chose colors similar to the rest of the ensemble on two occasions (Outfits 9, 10) and colors that contrasted with the ensemble



<p><b>Outfit 1</b>  <b>Participant:</b> Maya  <b>Item no:</b> 19 (black)  <b>Outfit:</b> Blue shirt inside, black suit outside, dark jeans  <b>Position of object:</b> Pocket</p>	<p><b>Outfit 2</b>  <b>Participant:</b> Maya  <b>Item no:</b> 19 (black)  <b>Outfit:</b> Acne Sheer grey blouse, dark jeans  <b>Position of object:</b> Hand</p>	<p><b>Outfit 3</b>  <b>Participant:</b> Maya  <b>Item no:</b> 2 (brown)  <b>Outfit:</b> Beige cashmere sweater, brown belt, jeans  <b>Position of object:</b> Hand</p>	<p><b>Outfit 4</b>  <b>Participant:</b> Maya  <b>Item no:</b> 4 (brown)  <b>Outfit:</b> Filippa K. Grey long blouse, brown belt, jeans  <b>Position of object:</b> Hand</p>	<p><b>Outfit 5</b>  <b>Participant:</b> Christina  <b>Item no:</b> 22 (black)  <b>Outfit:</b> Cream cardigan, Monki blue velvet dress  <b>Position of object:</b> Brooch</p>	<p><b>Outfit 6</b>  <b>Participant:</b> Christina  <b>Item no:</b> 22 (black)  <b>Outfit:</b> Prints' dress inside, Black blazer outside  <b>Position of object:</b> Pocket</p>
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**Table 1 Variations of outfits: Maya and Christina**



<p><b>Outfit 7</b>  <b>Participant:</b> Alice  <b>Item no:</b> 18 (black)  <b>Outfit:</b> Yellow dress, black leather jacket, Converse flats  <b>Position of object:</b> Necklace</p>	<p><b>Outfit 8</b>  <b>Participant:</b> Alice  <b>Item no:</b> 22 (black)  <b>Outfit:</b> Yellow dress, red lip clutch, necklace, black high heel shoes  <b>Position of object:</b> Hand</p>	<p><b>Outfit 9</b>  <b>Participant:</b> Alice  <b>Item no:</b> 13 (white)  <b>Outfit:</b> White sleeveless top, blue plaids skirt, red flat shoes, lipstick necklace,  <b>Position of object:</b> Hand</p>	<p><b>Outfit 10</b>  <b>Participant:</b> Alice  <b>Item no:</b> 17 (black)  <b>Outfit:</b> Dark grey T shirt, Weekday dark jeans, grey leather boots  <b>Position of object:</b> Hand</p>	<p><b>Outfit 11</b>  <b>Participant:</b> Emma  <b>Item no:</b> 6 (beige)  <b>Outfit:</b> H&amp;M Black blouse, black miniskirt, necklace, silver watch, Black leather boots  <b>Position of object:</b> Necklace</p>	<p><b>Outfit 12</b>  <b>Participant:</b> Emma  <b>Item no:</b> 8 (beige)  <b>Outfit:</b> H&amp;M Black blouse, black miniskirt, necklace, silver watch, Black leather boots  <b>Position of object:</b> Bag</p>
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**Table 2 Variations of outfits: Alice and Emma**



<p><b>Outfit 13</b>  <b>Participant:</b> Emma  <b>Item no:</b> 9,16(white, black)  <b>Outfit:</b> H&amp;M Yellow blouse, H&amp;M black pants  <b>Position of object:</b> Necklace</p>	<p><b>Outfit 14</b>  <b>Participant:</b> Emma  <b>Item no:</b> 9, 18(white, black)  <b>Outfit:</b> H&amp;MYellow blouse, H&amp;M black pants  <b>Position of object:</b> Necklace</p>	<p><b>Outfit 15</b>  <b>Participant:</b> Emma  <b>Item no:</b> 20(black)  <b>Outfit:</b> Monki Black sleeveless dress, thin brown belt, H&amp;M brown pump shoes  <b>Position of object:</b> Shoe lace</p>	<p><b>Outfit 16</b>  <b>Participant:</b> Klara  <b>Item no:</b> 14(white)  <b>Outfit:</b> Black graphic T shirt, black cardigan, black jeans  <b>Position of object:</b> Brooch</p>	<p><b>Outfit 17</b>  <b>Participant:</b> Klara  <b>Item no:</b> 14(white)  <b>Outfit:</b> Black graphic T shirt, black cardigan, black jeans  <b>Position of object:</b> Ring</p>	<p><b>Outfit 18</b>  <b>Participant:</b> Klara  <b>Item no:</b> 17(black)  <b>Outfit:</b> Black graphic T shirt, black cardigan, black jeans  <b>Position of object:</b> Necklace</p>
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**Table 3 Variations of outfits: Emma and Klara**

ble on two other occasions (Outfits 7, 8). Thus, color is also of importance when matching the outfit.

### Number of Samples

The way Emma used a combination of samples in the outfits (Outfits 13 and 14) displayed a possible implication of the concept investigated. She first picked a light yellow blouse (Outfit 13), which was matched with a pair of black pants, and accessorized them with a silver bracelet. She then picked two samples (no. 9 and 16) and tried to explore which fit best. Interestingly, she selected both of them. Then she exchanged the flat black item (no.16) for a slightly more organic black item (no. 18). This created a new outfit (Outfit 14). Picking two items for one example was not in accordance with our instructions, since we envisioned the entire range of shapes as emerging from a single shape-shifting device. Still, her creative approach and reluctance to follow instructions show that there is interest in the possibility to vary shapes and combine more than one device with an outfit.

### Preferring a Fixed Shape

Two of the participants stated in the interviews that they were little inclined to use more than a single sample. Maya, for example, picked the black sample no. 19 to match two different outfits (Outfits 1, 2). The black suit was selected for work, and especially for formal meetings, and she matched it with a shirt and black pants. She did not want the sample to be seen and preferred to tuck it away in her pocket. For after work, she would wear a sheer blouse with a black tank top inside, a belt, and a pair of black jeans, complemented with black high-heel shoes (Outfit 2). Although the outfit is very different she would stick with sample no. 19. In Outfits 3 and 4 other combinations of samples and clothing are examined, but she told us that she did not like them. The color was appreciated, but the shape was not desirable.

Maya and Christina's dislike of switching between the different shapes can be understood in different ways. First, their preference for a single item might be due to an understanding of the set as comprising design variations of a contemporary mobile phone. This was evident in their comments on the items' usability. Asked to comment on the shapes, Christina said *"I will be very annoyed, I think. Because I cannot visualize, I think I'm very set in my mind, how could I press keys and use it? I also think, as phones become smaller and smaller, it's becoming unpractical. You can't find the phone. How do you talk?"* Her dislike seems to derive from her lack of understanding of how the interaction with the device functionality is solved. This points to limitations of our study, given that we only provided shapes and no devices with functionality. Her reaction shows that she finds it hard to conceive of mobile phones and fashion accessories as one and the same thing. This motivates a need for a next step studying prototypes of shape-switching devices with functionality. For many people, like Christina, a mobile phone

is more like a tool, not a place where their interest in fashion is expressed. Second, Maya mentioned that she was *"trend sensitive,"* a quality that makes it important to follow what is considered fashionable. It can be difficult to comment on a research prototype that is weakly linked to traditional fashion guidance. This points to a weakness in how the design concept is connected to the fashion system, even if the design was directly grounded on and inspired by shapes, materials and colors from the local fashion style that Maya, at least on the surface, would seem to be part of. Third, her preference for an item might have been influenced by personal taste [5]. Emma and Alice, who varied their use of samples with different outfits, said that they liked the shapes. Maya and Christina, on the other hand, did not like the items, since they did not match their minimalistic style. Maya said: *"It would be like I had already worn them for 24 hours, ha ha... they get wrinkled, so it's a wrinkled feeling. It's not something I'd take with me in the morning. I'd need to iron this."* Her taste leaned towards the sort of shapes that appear when the body moves, rather than shapes made by stitches and sewing. This again would probably be very different if it had been a functioning device.

Summing up, two participants refrained from selecting more than one sample, which could be seen as a negative reaction towards the concept. It did not appeal to them to have an object that can change shape in this way. But it could also just be a reaction to this particular instantiation.

### Aesthetic Appeal

The study provided feedback about the specific instantiation of "Swedish style." First, the participants commented upon the texture of the mock-ups. Maya's first impression was that: *"it looks like summer fashion to me. Because I see these as cotton, but also the texture of linen."* Like the visual orientation in fashion practices [19], she discussed how it looks rather than how the samples feel. The visual impression of a certain texture had a great impact on how she chose to match the object to clothes. This tells us something about the level of detail to which an organic interface has to adapt. To a fashion-conscious person, if the surface texture is undesirable, it might not help that it can change shape. Second, the participants often considered the size of the samples. Maya thought they were too large to wear on clothes. Christina picked the same black, shaped item all the time, partly because it was "smallest." For Emma, a large accessory could create drama in contrast with her other clothes. The feedback about the importance of size concerns how folding could be used to change the overall size. The possibility of switching shape to affect size could improve matching.

### DISCUSSION

In the following we discuss how fashion practices can be used to inspire new approaches to interaction design in the mobile domain. More specifically, we address the concept of outfit-centric design, as well as the learning of

the specific instantiation in fashion styles and technology related to four themes [3]:

- Materials of fashion: Mobile fashion beyond hard covers and stickers
- Role of the designer: Emphasizing the importance of style in product and interaction design
- Social context of fashion aesthetics: The locally situated, time-dependent, and publicly visible appearance
- Fit with dressing practices

### **Mobile Fashion beyond Hard Covers and Stickers**

It is today a common practice to change the public visual appearance of a smartphone by adding e.g. covers or stickers. Our approach expands on these possibilities in several ways. First, with a three-dimensional exploration we move beyond a rectangular device, and the variety of shapes offers greater diversity in appearance. Second, the different shapes and sizes allow for experimentation with location on the body. Third, the design exercises reveal the potential to design applications that connect visual aesthetics of mobile devices to dress ensembles (e.g. prêt-à-porter, social media, etc.). Fourth, the design exercises display outfit concepts that are inherent in the device, and thus allow for more extensive variation than selecting from among hardware gadgets that in themselves are fixed in form and appearance.

The previous design exercise by Kashanipour [17] showed the difficulties in changing the publicly visible appearance of a mobile device, and resorted to using stickers to accomplish this. The Mobile ActDresses [14] went a step further by exploring the changing of covers, which is already an established practice, in closer relation to how it may be used to interact with software. However, realizing such a concept requires the development of technical means in standard mobile phones. In all, it seems that smartphones have critical hardware restrictions that make it difficult to support applications that fully embrace the concept of outfit-centric mobile design.

In the design exercise reported in this paper, we instead choose to seek inspiration in the emergent technology of organic interfaces. This gives us more freedom to experiment with public visual design. However, the downside of such an approach is the uncertainty regarding the potentials of this new design material. As with other design-oriented research, we risk engaging in a more or less meaningless activity, since we may have exaggerated the technologies' capabilities [12]. However, if organic interfaces do live up to some of their promised potential, we will soon need to discuss "how" they should change their forms, rather than just being amazed that they "can." Inspired by the soft fabric folds in the local fashion style of this study, the design exercise points to what variation based on organic interfaces could potentially look like when applied to mobile design. Whereas stickers and covers also meet the demands of being publicly visible and being prêt-à-porter, the exploration presented here

goes a step further by using an approach specifically inspired by emergent technology, and grounded in a particular local dressing style.

The results of the user study reveal other opportunities to apply the outfit-centric concept. First, an option not investigated with smartphones was to use social media as public arena to display the device in combination with the outfit. Then, the focus would be on visibility on the Internet. Second, the participants' interest in color variation, as displayed in the second design exercise, could be utilized in design solutions that do not support shape switching. Color variation combined with dress ensembles could be achieved by changing covers, but also by adding screens on the sides or back of a mobile device. This approach would require new hardware, but not as futuristic a technology shift as organic interfaces. It might instead have other drawbacks, e.g. increased battery consumption, but is still an interesting topic for future exploration.

The exploration could also be read as a commentary on what high-tech interactive products usually look like, and the potential design space that emerges when one begins to consider devices that need not be hard and rigid in form. It should be noted that the samples presented here (Fig. 2) actually were physically hard to the touch, and therefore similar to wave-shaped architecture, e.g. the Guggenheim Museum designed by Frank O. Gehry [20]. Similarly however, they also express an alternative aesthetic agenda that moves away from the flat and symmetrical, which is also strongly present in the explored local dressing style on which this study is based. The hard and static shapes were also intended mainly for visual presentation, and the ultimate aim is shapes that would be soft and interactive.

### **The Role of Style in Product and Interaction Design**

Prêt-à-porter, which is the French word for ready-to-wear, means clothing fabricated for mass distribution and consumption [21]. In fashion studies, it is widely accepted that garments and accessories for the most part are not made by consumers, but bought in stores [31].

The predominance of prêt-à-porter within fashion, and its use in the design exercise, opens the possibility to adhere to mechanisms such as designer labels and style. Individual designers are made important in the production of fashion, and many famous fashion brands are named after the founding designers, which personify the fashion design [19]. This is in contrast to product and interaction design, where designers are often de-emphasized, making the items less personal. Especially in HCI, with for example its proposed participatory design methodologies, the role of the designer and the specific tastes, styles, and cultural connotations that this may bring to a specific design project, have been almost entirely left out of the academic discussion. The most similar approach is sometimes labeled the "design" approach [2]; in it the manufacturing is done by professional designers and is part of an established cycle of the design, production, and con-

sumption of goods. Here an industrial designer provided expertise in creating the shapes as a way to emphasize the role of the designer in production, while also paying special attention to local norms in fashion.

### **The Social Context of Fashion Aesthetics**

An important aspect of fashion is the phenomenon of local styles, which convey an initial general impression that persists between different items [19]. This study draws upon a particular style as it appeared at the time and place of the study. This means that the samples were not intended to please everyone, but to illustrate how a particular manifestation of a fashion can inspire new designs of interactive products. The important point here is to trigger discussions of how the design of digital devices and applications could be molded into specific fashion styles, and how these fundamentally differ.

In line with how fashion items are visible to the wearer and people in the vicinity [19], the outfit-centric design principle focuses on the artifact as being visible to others, and as part of an ensemble. Our attention was therefore directed towards visible features such as shapes and color, to be seen at a glance. That our participants adhered to the same principles was perhaps most apparent in the attention they paid to the placement of the design items on the body. The samples were presented as necklaces, brooches, a ring and a small bag etc. These forms of use offer different amounts of visibility in social encounters, as well as setting the items in different contexts, e.g. next to the trousers when used as a belt and next to a blouse when used as a necklace. All the participants' experiments, except that of Maya, who thought of tucking it into in a pocket, show that public visibility is a relevant concern among these fashion-conscious participants, and that our samples can serve to meet that demand.

On a theoretical level, the study tells us something about how to strike a balance between the senses when designing artifacts to function as fashion items. HCI has recently turned to aesthetics as a way to better cater for experience in design. The pragmatist philosopher Dewey [6, p.14] has been particularly influential, for example, with his argument that an experience balances all our senses, such as sight, smell, and touch, and counteracts compartmentalization and fragmentation. This idea has subsequently guided the design of digital artifacts, and specifically led towards increased physical, or bodily, interaction with computers [24]. In this study, we do not aim to conduct such a general discussion. The contribution here targets a particular domain of use. Although we recognize that fashion practices have to do with more than just the sense of sight, for example the tactile feeling of a dress or a shoe, our user study, together with previous findings [16], tend to emphasize properties that can be shared with others, i.e. the publicly visible appearance.

### **Dressing Practices in Interaction with Technology**

Fashion-conscious people are part of a culture, which thrives on continuous change and transformation [19, 30]. In particular, the concept of outfit-centric design grew out of the identification of a difference between how often we change items of clothing and digital devices. People change their outfits on a daily basis and add new garments to their wardrobes a lot more often than they change their mobile phones. This temporal variation can be of different kinds. First, there are daily changes depending on context of use, e.g. working at an office or going to a party. The participants varied the shapes of the items in a way that matched how they change outfits. For example, Alice suggested that she would change it twice a day when creating a day look and an evening look. This type of variation has to do with choosing from among a set of items available in the wardrobe, or pre-designed shapes in our design exercise. Second, the variation depends on the range of shapes available, similar to the number of items of clothing of a particular type that people have in their wardrobes. The way in which our participants varied their choice of clothes and accessories was not the same for every type of item or garment. For example, they could choose from among a large set of shirts, but a small number of bags. The range of variation is then influenced by whether, e.g. the shapes are perceived as resembling a bag or a shirt. This suggests that the range of variation would be smaller if it is perceived as a bag than if it is perceived as a shirt. This might influence the desirability of the system.

The question investigated here is whether technologies, with characteristics similar to organic interfaces, could increase the pace of visual-design change among digital devices, and make them considered more integrated as part of a person's outfit. But understanding how to account for the pace and scope of change is a challenge, and would involve more than just this first exploration.

### **CONCLUSION**

Our aim was to explore the concept of a mobile phone more closely integrated with everyday dressing practices, and one that more easily can be adapted to a variety of looks. With everyday dressing practice as a starting point, we further studied a particular style of fashion, "Swedish style," and explored twenty-two samples having different shapes and four groups of colors, which we call "shape switcher." We conducted a user study on five women all with an aesthetic orientation towards the explored dressing style. Participants did vary the samples with different outfits, but in discussing the items as potential shapes for mobile phones, some of them were rather hesitant. This study is relevant for HCI, as it deals with issues such as visual aesthetics and emergent technology, as well as wearable computing. It points to opportunities to pursue mobile design that is more firmly grounded in the study of fashion practice.

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