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Expressive Wearables: Practices-Oriented Codesign for New Forms of Social Mobile Technology

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ABSTRACT

Self-expression is a vital practice for a functioning social life. Wearables have become expressive everyday products, while studies showed how physical collocation can be an opportunity for social technology. This article identifies a perspective for future design of wearables as an extension of the body in its social context: designing for diversity in expression with respect to social boundaries. The collected literature demonstrates the development of new forms of expressive wearables that challenges norms of dress and three groups of participatory methods enable re-search into everyday life practices. The two initial studies—inquiring into everyday life and exploring the wearable design for new practices—exemplify these methods and point a way forward with a focus for design on distinct practices of self-expression.

KEYWORDS

INTRODUCTION

In Human-Computer Interaction (HCI) there is a history for improving interactions between people occupying the same space and time. Already in the last century collocated social interactions have been supported by digital badges or public displays in conference settings to initiate face-to-face interactions or group awareness (Falk & Björk, 1999; McCarthy, 2002). Forming connections between people through mobile devices based on physical collocation is not just research anymore (Eagle & Pentland, 2005), but everyday reality with commercial applications like happen (‘happn - Find the people you’ve crossed paths with’, n.d.).

Ongoing advancements in computing technology enables an ever-increasing variety of wearable devices and smart clothing. With these computing capabilities digital information reaches all aspects of life, including social interactions in physical space. Research in HCI investigates wearables not merely as personal items. When worn in visible range to others, these wearables become public – so called social public displays. These displays take the form of mobile devices with additional displays (Jarusraiboonchai, Malapaschas, Olsson, & Väänänen, 2016), smartwatches (Pearson, Robinson, & Jones, 2015), clothing (Mackey, Wakkary, Wensveen, & Tomico, 2017), accessories (Colley, Pakanen, Koskinen, Mikkonen, & Häkkilä, 2016; Rantala, Colley, & Häkkilä, 2018) or body augmentations (Dierk, Sterman, Nicholas, & Paulos, 2018; Hartman, McConnell, Kourtoukov, Predko, & Colpitts-
Campbell, 2015). With this, mobile devices become more than a computing interface for the wearer but extend the wearer’s body with new forms of expression in its social context.

The dynamic information presented by such displays, whether implicit (e.g. changing colours in a dress) or explicit (e.g. displaying a political statement), can change the impression we have on others. But in social life managing these impressions is vital to form relationships, whether in professional or private life (Goffman, 1959; Leary & Kowalski, 1990). This form of presenting oneself to others does not just serve to make a “good impression”, but also to express identity or belonging to a group, e.g. a student wearing a distinct outfit as a way to identify with his faculty.

From research in online social networks we know now, that these connections do not just improve social life, but can be demanding (Van Dijck, 2013). In particular the design of social media platforms like Facebook requires to present a uniform persona, which sometimes disturbs people’s behaviour to present different roles to different people (Farnham & Churchill, 2011; Van Dijck, 2013).

Besides empirical research on smartwatch use in context (McMillan et al., 2017) HCI research has mainly focused on enhancing social interactions through computer-mediated communication within a distinct context of planned events like education and conferences (Chen & Abouzied, 2016; Nelimarkka, 2018) or activities, like sports (Mauroiello, Gubbel, & Froehlich, 2014). But contrary to a lot of works the context of use is rarely static (Jumisko-Pyynkkö & Vainio, 2012), especially when we consider that wearables are constantly with us. With computing technology entering the physical space through smart textiles, clothes turn towards dynamic expression. Fashion as an aspect of shaping identity and social life needs to be considered besides mere investigations of information exchange (Juhlin, 2015; Mackey et al., 2017; Tomico, Hallnäs, Liang, & Wensveen, 2017).

As “the push for wearable computing has so far been coming from the technology side” (Häkkilä, 2017), social challenges should be investigated through design research. By studying possible futures, we can identify ways to improve social engagements and inform the design of new products and services before possible detrimental effects may disrupt the fabrics of society. Wiberg and Wiberg (2018) describe this challenge of digital integration as the Third Wave of Mobile HCI.

In this article I explain how my doctoral research investigates questions of diversity in people’s self-expression through extending the social body with wearable technology. An overview over the current state of the art hints towards new forms of self-expression with dynamic fabrics and fashionable wearables, that will challenge existing norms. Based on this I propose a focus on practices to tackle these challenges with research through codesign.

**BACKGROUND: EMERGING FORMS OF EXPRESSIVE WEARABLES**

The spectrum of possibilities to connect with people nearby has grown intensely in the last decade. Starting off in the last century with public displays and digital conference badges, HCI research investigated mobile devices for awareness, ice-breaking or collaboration (Lucero, Clawson, Fischer, & Robinson, 2016).

Today a majority of people have powerful computers in their pockets. These mobile devices enable mediated communication with people nearby with commercial applications like happen. Social matching becomes more opportunistic towards sharing a physical location (Mayer, Hiltz, Barkhuus, Väinämönen, & Jones, 2016; Paasovaara, Olshannikova, Jarusriboonchai, Malapaschas, & Olsson, 2016) and connecting to nearby devices enables collaborative activities to achieve tasks, socialise or have fun (Jokela, Chong, Lucero, & Gellersen, 2015), e.g. by sharing photos. Those interactions are played out in a hybrid space with the computer-mediated and face-to-face communication influencing each other (Nelimarkka, 2018). With new forms of integrating digital information into the physical appearances, this moves such interactions completely into the physical space. Here follows an overview over the different forms that exist to alter physical appearance and information at display and how they relate to the social aspects of everyday life.
Self-Expression Through Social Public Displays

Jarusriboonchai et al. (2016) defines devices that are personal, but publicly visible to others “social public displays”. One area of research is projector phones, which by design invite for interacting with others nearby, e.g. viewing and sharing photos (Greaves & Rukzio, 2010). Only exploratory studies actually looked at projections as public displays for social interactions (Cowan, Weibel, Griswold, Pina, & Hollan, 2012; Greaves, Akerman, Rukzio, Cheverst, & Hakkila, 2009; Ng & Sharlin, 2010; Wolf, Funk, Knierim, & Lüchtfeld, 2016). Other works deployed personal items with additional displays in the workplaces or school environment (André, Sellen, & Wood, 2011; Kao & Schmandt, 2015), handbags (Colley et al., 2016) or back displays on mobile devices (Jarusriboonchai et al., 2016) and laptops (Kleinman, Hirsch, & Yurdana, 2015).

Still these applications are bound to external displays and therefore separate the computer-mediated interactions from physical actions of our bodies. Besides projecting into the environment, smartwatches can be extended on the user’s arm (Xiao et al., 2018) or vapor can be released as a projection surface close to one’s body (Ens, Grossman, Anderson, Matejka, & Fitzmaurice, 2015). Still technical limitations prevail, as projections afford special lighting conditions (Wolf et al., 2016).

From early prototypes using digital badges (Falk & Björk, 1999) and wristbands (Fajardo & Moere, 2008; Williams, Farnham, & Counts, 2006) recent works explored these designs in collocated scenarios like conferences using playfulness (Chen & Abouzied, 2016) or proximity (Jarusriboonchai, Olsson, Prabhu, & Väänänen-Vainio-Mattila, 2015) as cues for expression. With the commercial availability of smartwatches research looked how these personal devices can become social by using their displays with collocated people (Pearson et al., 2015).

From Wearable Devices to Dynamic Fashion

Nowadays wearables are not just areas of research or niche products anymore, but commercially available fashion products. Activity trackers and smartwatches have transformed from functional devices – appearing more like worn displays – to fashion items on-par with traditional accessories in terms of aesthetics (‘RINGLY | Smart Jewelry and Accessories’, n.d.). Although still mainly used for means of personal tracking, self-expression becomes available through commercially available products, like accessories and clothing integrated with LEDs (‘CUTECIRCUIT | Wearable Technology, Fashion Technology’, n.d.), circular button displays for GIF animations (‘Pins Collective – Express Yourself’, n.d.) and bracelets with eInk displays (‘Tago Arc’, n.d.).

A large field of investigation are garments, as clothing is omnipresent and covers the most of our bodies. Early artistic explorations like the Galaxy dress show the capability of dynamic textiles, but practicality is still an issue. Devendorf et al. (2016) argue that the fast-paced dynamics of digital displays contradict social norms of dress. For example, showing notifications were investigated as an application for smart textiles (Fransén Waldhör, Vierne, Seidler, Greinke, & Bredies, 2017; Liu, Vega, Qian, Paradiso, & Maes, 2016; Schneegass, Ogando, & Alt, 2016), but notifications are known to disrupt face-to-face interactions (Mayer, Lischke, Woźniak, Henze, & Wo, 2018). Some works tried implicit visualisation in shirts for sharing physiological information as social cues (Howell et al., 2016) or more slow-paced explicit information integrating eInk displays in apparel (Dierk, Nicholas, & Paulos, 2018).

Besides clothing, cosmetics are an important part of dress. Prototypical implementations for visualisations exist for nails (Dierk, Galvez, & Paulos, 2017), hair (Dierk, Sterman, et al., 2018) and skin (Kao, Holz, Roseway, Calvo, & Schmandt, 2016).

Another way to extend personal appearance is augmented reality by adding information on jewellery (Ens et al., 2015; Rantala et al., 2018) or clothing (Häkkilä, Colley, Roinesalo, & Väyrynen, 2017; Mackey et al., 2017). If head-mounted displays become widely used, altering appearance of collocated people like this might become omnipresent. Mackey et al. (2017) used chroma keying on green clothes to augmented static and moving imagery. Posting these images online enabled a first study of wearing dynamic fabric in everyday life. From their long-term autoethnographic study they argue that trends change, therefore highly dynamic visualisations on clothes might become the norm.
Extending Appearance beyond Modalities of Traditional Dress

An aspect explored early in artistic works is shape-changing mechanisms for altering appearances. Max Schätih’s hoodie “e-Motion” visualises the emotional state of the wearer (Seymour, 2010); Anouk Wipprecht’s Spider Dress 2.0 reacts on proximity by fending off people coming too close with pointy legs (Ken Kaplan, 2015); And “Monarch” changes the wearer’s posture through shoulder plates (Hartman et al., 2015). Recently Kao et al. (2017) used robots freely roaming the surface of clothes to change looks dynamically. These kinetic interfaces offer self-expression through extending the wearers’ gestures. Other works even extended the body more literally through a wagging tail (Svanaes & Solheim, 2016), kinetic hair (Dierk, Sterman, et al., 2018; Lee, 2018) or controllable ears (Huang et al., 2018). Still gestures follow existing social norms and might be not acceptable in everyday life (Rico & Brewster, 2010).

There are also modalities for expressions beyond the visual, like sound (Beilharz et al., 2010; Choi et al., 2011; Jarusriboonchai, Olsson, & Väänänen-Vainio-Mattila, 2014), smell (Choi et al., 2011; Jarusriboonchai, Olsson, & Väänänen-Vainio-Mattila, 2014), temperature (Brueckner, 2018) or physical touch (Hobye & Löwgren, 2011). These offer new sensual experiences by using unusual modalities, but consequently only work in a specific context due to their novelty.

THE CHALLENGE OF SELF-EXPRESSION IN SOCIAL LIFE

From the current state of research on expressive wearables we can identify a very wide range of technological means to extend self-expression. Following this there is a push towards design in wearables research (Häkkilä, 2017), especially fashion (Juhlin, 2015; Tomico et al., 2017). Tomico et al. (2017) identify a next wave of wearables that are fashionable, in the sense that “social functions of technology converge with the social functions of dress”.

HCl often applies an input-output perspective between user and device. This is also the case for the design space of wearables (Schneegass, Olsson, Mayer, & van Laerhoven, 2016). From an anthropological viewpoint Tamminen & Holmgren (2016) argue against a functional perspective:

*Instead, the question of wearable technology should be re-articulated in terms of the relationship they have to our bodies, social selves, and our personal identities to arrive at more useful insights about the role of these technologies in our lives. (Tamminen & Holmgren, 2016)*

Especially expressive wearables call for a such a perspective, where wearables become situated in the social context of their use. When we look at social challenges, privacy is threatened by unwanted disclosure through these expressive devices and acceptability is challenged by their novelty (Grubert, Kranz, & Quigley, 2016). But if we look beyond these adoption issues, the question is, how such expressive wearables become a way of participating in society. There are opportunities for social engagement (Grubert et al., 2016) and on personal level for expressing individuality (Mackey et al., 2017). In particular it becomes apparent how clothes and wearables are similar, as they are with us through the day, but different in the sense that wearables offer highly dynamic expression (Mackey et al., 2017). This is an opportunity and challenge alike, as these dynamic expressions might offer people to present themselves in more diverse facets, but also introduce constrains limiting individuality through reconfirming norms from connecting to other social spheres (Nelimarkka, 2018).

An individual might perform a role, which is stigmatized in another social context (e.g. a mobile HCI researcher who refuses to use a mobile phone). In social media this can cause distress (Farnham & Churchill, 2011) and expressive wearables by their nature might spill over information from one social context to another.

An additional aspect is our sense of belonging. This brings pressure on the individual to perform his membership. Using the “right” signage (e.g. dress code) is important for being accepted as a
member of a community (Goffman, 1959). The overall social challenge in designing expressive wearables therefore exists in enabling the expression of individuality and at the same time allowing for boundaries between incompatible facets of a person.

The effects of these systems on social interactions become especially relevant, when we consider those wearables as “smart”. When giving away control to automation, this could lead to a disempowerment in presenting oneself to others. Instead of sharing data automatically e.g. life activity data (Ens et al., 2015; Jarurusiboonchai et al., 2016), we could see mobile services integrated into the user’s appearance as an extension of self and a chance for technological empowerment. Empowerment in this sense means for expressive wearables to respect the human right of self-determination (Ladner, 2015). Just as people’s relationships change, likewise ways to express oneself change. Smart wearables should allow for self-expression that adapts to these changes through learning in a collaborative act (Kuijer & Giaccardi, 2018).

With these developments in mind, the pressing question is: How can wearables extend people’s self-expression in respect to the dynamics of social life?

This question is not concerned with the world as is, but tries to anticipate a desirable future.

**PARTICIPATORY METHODS FOR EXPRESSIVE WEARABLE DESIGN**

As this research tries to investigate social challenges of future development, one way to investigate this is research through design by constructing novel experiences (Koskinen, Zimmerman, Binder, Redstrom, & Wensveen, 2013). The aim for the design is to empower people in their social interactions and therefore calls for participatory methods (Bødker & Kyng, 2018). In the design of mobile interaction, the majority of studies still do not consider participatory methods (Stigberg, 2017). Thus, this section proposes methods for codesigning mobile interactions with a focus on expressive wearables.

The movement of service design has a history of participation. Sanders and Stappers (2014) argue when designing for the future, codesign needs to go beyond product-oriented service design to social design, that tries to bring change to society. Bødker & Kyng (2018) argue that design that wants to take participation seriously and empower people has to follow a set of principles. These principles make it inevitable to ground all design activities in the everyday life of users. Based on the developments in Participatory Design, scholars try to establish a “Practice Paradigm” besides the predominant “Interaction Paradigm” in HCI, to focus on everyday life practices and not primarily the interaction between artefact and user (Kuutti & Bannon, 2014). Kuijer (2017) tries to define this approach as “practices-oriented design”, where the primary unit of investigation is not the artefact, the user or the interaction, but people’s practices. With the following methods I argue for what Kuijer (2017) defines “disrupting practices” by constructing new forms of expression with wearables.

**Ethnography Informed Codesign Workshops**

A first step in a design process that tries to empower the user starts before the actual design of any artefact (Sanders & Stappers, 2008). In Kuijer’s (2017) framework this corresponds with understanding the “target practice”, which is investigated. Building on a pre-existing target practices will help the design of experience that connects with people’s everyday life and can elicit positive change.

Ethnography in the form as proposed by Pink & Morgan (2013) as “short-term ethnography” does not aim to analyse an organisational context in-depth and build social theory, but inform design by immersing the design team into the everyday life of the user and focus on emerging topics meaningful to participants. Additionally, Kuijer (2017) proposes research into historic accounts of the targeted practice. In terms of social interactions this affords analysis of cultural norms.

But in order to ensure an empowerment in codesign, participants need a more active role. At early stages codesign workshops are a good method to identify openings for design and also define relevant problems. Researching expressive wearables affords a lot of complexity due to the dynamics of
social context, i.e. different people over different locations or changing relations over time. Scenarios offer a way how complex multi-layered interactions between participants and technologies can be imagined and developed (Jarusriboonchai, Olsson, Ojala, & Väänänen-Vainio-Mattila, 2014). In a later step rudimentary prototypes can be evaluated through role-play to take complexity into account (Jennings, Roddy, Leckey, & Feigenblat, 2015). Building on the ethnographic accounts will help here to established realistic scenarios the participants can identify with.

**Participatory Making of Digital Artefacts**

The practice of design itself can be a source for generating knowledge (Koskinen et al., 2013). In Codesign this is acknowledged as participants are seen as experts of their own everyday life (Bødker & Kyng, 2018).

The introduction of the Lilypad microcontroller lowered the entry level for crafting smart textiles and therefore also wearables (Buechley & Eisenberg, 2008). A way to actively engage amateur users in designing digital technology are electronic toolkits (Jarusriboonchai, Meissner, Hansen, & Schouten, 2018), as they offer another layer of abstraction for creating electronic prototypes. 1^CATch improved on the Lilypad design through its plug and play characteristics (Ngai et al., 2010). Recent toolkits like MakerWear (Kazemitabaar et al., 2017) and YAWN (Thar, Stönner, Heller, & Borchers, 2018) lowered the barrier of entry again with a modular system and simplified interconnections. But besides toolkits, new tools for crafting electronic textiles emerge constantly (Mikkonen & Pouta, 2015; Perner-Wilson, Buechley, & Satomi, 2011; Posch & Fitzpatrick, 2018).

In terms of wearable technology choosing groups familiar with crafting electronics or clothing might help the participatory implementation efforts. Nevertheless, by iterative prototyping and consequently thinking about possible design solutions and their results, participants become empowered not only by participating in the design and testing, but also in prototyping and analysis (Ladner, 2015).

**In-the-Wild Studies with “Working Prototypes”**

The ultimate goal towards answering questions of everyday life are studies in the wild (Johnson, Rogers, van der Linden, & Bianchi-Berthouze, 2012). Insights into people’s practices, not limited to a single social context require longer-term evaluation. This can be gained by mobile probes (Mattelmäki, 2008), which mixes experience sampling and active participation in playful activities. But in terms of expressive wearables this requires “working prototypes” to have an impact in people’s practices (Bødker & Kyng, 2018; L. Kuijjer, 2017). In this way a prototype can be tested as physical hypothesis (Koskinen et al., 2013) in the everyday context.

A recent example for studying social displays in everyday life can be seen by Jarusriboonchai et al. (Jarusriboonchai et al., 2016). Their device shared the current application a participant is using on his mobile phone to people in close proximity via an e-ink display attached to the back of the device. While their goal was to raise awareness and spur serendipitous engagements between people, one outcome was a change in behaviour of the participants. With an additional feedback channel, people reported self-regulation of their mobile phone use.

A way to capture data on self-expression is self-photography (Isomursu, Kuutti, & Väänämö, 2004; Mackey et al., 2017), as it respects the actual appearance of participants.

Ultimately the effort of following participants for a long time as close as needed to reveal changes in their practices is critical due to privacy issues and the sheer amount of data. One possibility is to use the researcher or designer as the subject in autoethnographic studies by wearing expressive technology themselves (Mackey et al., 2017). This limits the findings to a very unique case but helps for longer investigations of changes in the appropriation of technology from a subjective viewpoint.
RESEARCH CONDUCTED SO FAR

The empirical research in this work so far spanned two extremes: from inquiries into everyday life to speculative design exploration.

Opportunities and Challenges of Mediated Self-Expression in Public

In HCI works have pointed towards opportunities and challenges of sharing personal information to collocated people through technology (Jarusriboonchait, Olsson, Ojala, et al., 2014). Studies have investigated such mediated self-expression, but only in distinct social settings. We conducted 30 interviews in different public urban settings to understand people’s notions towards mediated self-expression. Participants were asked to customize a paper sticker to be applied to their clothes in order to express themselves with a wearable display in public.

Early results indicate how social context has a strong influence on the rules around using such an artefact. In planned events people followed similar strategies, as opposed to more public and anonymous places. But especially the current state of a person had an effect on the content and strategy in using such a sticker (see Figure 1). Besides using the sticker as an ice-breaker to initiate a conversation, people formulated a desire for connecting with people in the same location without actively engaging in face-to-face interactions. Overall the results indicate very diverse use for personal expression and show entry points for social interaction design in their context. This study exemplifies how grounding participation in people’s everyday lives can reveal factual accounts of opportunities and challenges for further design research.

Figure 1. Four of the stickers created by participants at a museum lobby (Epp, 2018)
**Hooze: The Designer as a Social Body**

A different work is Hooze (Zdziarska et al., 2019), a zoomorphic fashion accessory that entices touch through its kinetic qualities and visual appearance. In this work a design group explored through speculative design practice how wearables might support sociability. Hooze was developed in a week-long workshop on “wearables that matter”. The approach was to address wearables as extensions of the physical and social body. Questioning how physical touch is perceived, we created a fashion accessory, that sits on the shoulder. Using fur, we build on its material characteristics to entice sensory exploration. Amplified by a servo motor, the structure created a subtle flapping motion through its elastic built. Adding to the animalistic characteristic we used capacitive touch sensing in the fur and haptic motors to give the wearable live-like behaviour. Different durations of stroking lead to different states of rest, attraction, agitation through intensified vibrations and the flapping motion.

Reflecting on the reactions inside the design group, the other workshop attendees and passers-by during an exploration to the city centre, we identified how Hooze was enticing social and physical engagement, facilitating humour and social play and invited to sharing a moment (see Figure 2).

The process of the design team in exploring the qualities of the artefact in its social context of the workshop and the group activity itself, was indispensable in understanding the social role of the wearable. Autoethnographic accounts, as subjective as they might be, reveal insights, which are hard to grasp in any user evaluation, as they acknowledge the designer or researcher as a social being. In this work the design group in itself poses a social context and therefore helps our understanding of expressive wearables.
FUTURE WORK

As stated, a perspective of wearables as an extension of the social body is necessary to design technology that integrates into the fabric of everyday life. The article identified practices-oriented design as a way to design for a future of digitally augmented self-expression with wearables for diversity and inclusion.

For this doctoral research this affords a more focused target practice. Example practices that could be changed with technological means could be “fitting in” in a particular community or urban public life or “expressing individuality”. Where Hooze focused on particular individuals in form of the design group, the field study using stickers did not. Further investigation will focus on particular individuals and their practices over a longer time.

This research therefore will combine the aforementioned methods in a codesign approach. Workshops will inform prototyping. In-the-wild investigations will feed back to prototyping and in a longer deployment help to answer the questions of expression beyond a single social context.

The autoethnographic notion becomes important to open for a more subjective insight. Just as an ethnographer becomes a member of a community in participant observation, in this approach the designer performs as a member of a community in a codesign effort.

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