Department of Computer Science, Department of Design

Augmenting Appearance with Wearable Technology

Open-ended Practices-oriented Design for Adornment and Identity as Routes to Adoption

Felix Anand Epp

Aalto University

DOCTORAL THESES

Aalto University publication series
DOCTORAL THESES 179/2023

Augmenting Appearance with Wearable Technology

Open-ended Practices-oriented Design for Adornment and Identity as Routes to Adoption

Felix Anand Epp

A doctoral thesis completed for the degree of Doctor of Science (Technology) to be defended, with the permission of the Aalto University School of Science, at a public examination held at the lecture hall T2 of the school on 27 October 2023 at 12:00.
https://aalto.zoom.us/j/64457313993

Aalto University
School of Science
Department of Computer Science, Department of Design

Supervising professors
Professor Marko Nieminen, School of Science, Aalto University, Finland
Professor Turkka Keinonen, School of Arts, Design and Architecture, Aalto University, Finland

Thesis advisors
Senior Lecturer Antti Salovaara, Aalto University
Assistant Professor Elisa D. Mekler, IT University of Copenhagen, Denmark

Preliminary examiners
Professor Kristina Höök, KTH Stockholm, Sweden
Associate Professor Minna Pakanen, Aarhus University, Denmark

Opponent
Professor Kristina Höök, KTH Stockholm, Sweden

Aalto University publication series
DOCTORAL THESES 179/2023

ISBN 978-952-64-1495-9 (printed)
ISBN 978-952-64-1496-6 (pdf)
ISSN 1799-4934 (printed)
ISSN 1799-4942 (pdf)
http://urn.fi/URN:ISBN:978-952-64-1496-6

Images: Felix Anand Epp, if not stated otherwise.

Unigrafia Oy
Helsinki 2023

Finland

NORDIC SWAN ECOLABEL
Printed matter
4041-0619

Aalto University

Abstract

Aalto University, P.O. Box 11000, FI-00076 Aalto www.aalto.fi

Author
Felix Anand Epp

Name of the doctoral thesis
Augmenting Appearance with Wearable Technology

Publisher School of Science

Unit Department of Computer Science, Department of Design

Series Aalto University publication series DOCTORAL THESES 179/2023

Field of research Human-Computer Interaction

Manuscript submitted 8 April 2023 **Date of the defence** 27 October 2023

Permission for public defence granted (date) 15 June 2023 **Language** English

☐ **Monograph** ☒ **Article thesis** ☐ **Essay thesis**

Abstract

Adornment, as a practice that expresses personality through appearance alterations based on clothing and other embellishments, is fundamental to all cultures. Hence, the social function of 'wearables' exemplifies a core application of technology. In the last two decades, advancements in wearable and ubiquitous computing have yielded novel forms of augmenting humans' appearance and face-to-face social interactions, ranging from smart clothing/accessories to bodily and augmented-reality-based modifications. Yet, notwithstanding its potential to drastically alter our social lives, the adoption of wearable technology has been limited to primarily health-related applications. Studies of 'social wearables' and expressive technologies have revealed barriers to adoption related to social acceptability and identity conflicts. Though recent efforts have led to guidelines and frameworks, the challenges of designing to overcome those hindrances remain. Conceptualising wearable technologies for appearance augmentation in terms of the social practice of augmented adornment, this doctoral research investigated how augmented adornment shapes social practices and identities. Utilising generative design research, it identified design guidelines that support the adoption of interactive expressive wearable technologies. Following an approach wherein the investigation and design process are centred on the practice, not the user, the work drew together ethnographic fieldwork, co-creative design, and open-ended technological interventions. The dissertation presents three case studies of employing practices-oriented design to investigate social practices of adornment in situ in Finland: an exploratory case study considering a zoomorphic accessory for eliciting social touch; an exploratory study examining opportunities for displaying personal sketches on one's clothing in urban public spaces; and an extensive investigation, conducted over a two-year span, of the striking tradition of Finnish university students wearing and adorning boiler suits. All three field studies revealed ways in which the meanings of a personal-identity-connected adornment practice form a crucial aspect of augmenting appearance, with the final study demonstrating an especially vivid interplay between embracing local traditions and standing out through individualistic adornments – the students linked their novel practices of augmented adorning to an existing digital practice, e.g. memeing. The findings exemplify an open-ended, dialogue-based perspective and a practices-oriented approach for generating further intermediate design knowledge. As a first milestone, the work presents a strong concept for design called Memetic Expression. By situating augmented adornment in context as a social practice, the results should assist designers in embedding social wearables in people's lives. The design approaches presented offer assistance in working through conflicts that might arise by merging digital practices with adornment and helping pinpoint routes to adoption.

Keywords Wearable Computing, Design, Social Interaction

ISBN (printed) 978-952-64-1495-9 **ISBN (pdf)** 978-952-64-1496-6

ISSN (printed) 1799-4934 **ISSN (pdf)** 1799-4942

Location of publisher Helsinki **Location of printing** Helsinki **Year** 2023

Pages 188 **urn** http://urn.fi/URN:ISBN:978-952-64-1496-6

Acknowledgements

For me, the doctorate has been a special kind of journey. At times, it brought me to my limits. Even more so, I'm grateful to have had advice from many great minds along the way. First and foremost, my advisers over the last years – Elisa D. Mekler and Antti Salovaara – merit recognition: more than any of the extensive academic support and detail-level assistance, from multiple quarters, I am grateful for your trust in me. Elisa managed to help me keep my destination in sight; especially when times seemed gloomy, our relationship and chats were the fuel I needed. Antti's unwavering belief in my abilities, in turn, gave me the support I needed to see the writing through to completion – his sharp, relentless analytical questioning helped me maintain the focus that can prove so elusive for an explorative mind such as mine. Next, I thank my supervisors, Marko Nieminen and Turkka Keinonen, for helping me along the final stretch to the finish line in writing this dissertation. A special thanks deserves Tapio 'Tassu' Takala, not just for his supervision and guidance but also for his enthusiasm and his personal insight that enriched my understanding of 'Teekkari' culture. Next, Andrés Lucero was never reluctant to share his wisdom. It was he who opened the doors to the Department of Design, which feels like home to me now. Finally, I am forever grateful to David McGookin, who enabled and supported this opportunity to ask questions and pursue answers. In addition, I have had the good fortune of being examined by Minna Pakanen and Kristina Höök, both of whom have supplied constructive feedback throughout and have helped me see my work with new eyes.

Numerous other inspirational characters accompanied me on the way. First, Mary Karyda, whose tenacity was especially inspiring, has found a special place in my heart and will always have a place in my home. In my group, I began the process with Ilyena Hirskyj-Douglas. Thanks to challenging me intellectually, hers was the single greatest influence on finding my voice. Similarly, Anna Kantosalo was a great companion and deserves a warm thanks; just as Mikko Kytö, Beatrice Monastero, and Laura Maye for the laughter and pointers chart my course.

There are plenty of other companions I could rely upon to lead the way or walk next to me. The many paths paved by Ding Wang, Emrecan Gulay, Emmi Pouta, Jesse Haapoja, Janin Koch, Marco Will, Mikko Illi, Nils Ehrenberg, Patrycja A. Zdziarska, Tania Chumaira and Walther Jensen have all been an inspiration. I hope our paths keep crossing.

Special thanks go to my dear friend Thomas Grah, for planting the initial idea, and to Aakash Sharma, who gave me the last push to pursue a doctorate.

My family form the final part of the web that made my doctorate a reality. I feel blessed with what you have provided my with to always search for new adventures. The most prominent among them is Maria Serena Ciaburri, my biggest fan and eternal flame. I value all of your contributions, from your emotional strength and the beautiful life you allow me to live to your nerdy help in crafting and discussing my thoughts. Duiiiii!

Espoo, 10 October,

Felix Anand Epp

Contents

List of Publications

This thesis consists of an overview and of the following publications which are referred to in the text by their Roman numerals.

I Felix Anand Epp, Ilyena Hirskyj-Douglas, Maria Karyda, David McGookin, and Andrés Lucero. Collocated Sharing of Presentations of Self in Public Settings. In *Proceedings of the 19th International Conference on Mobile and Ubiquitous Multimedia (MUM '20)*, Essen, Germany, ACM, New York, NY, USA, 191–200, Honorable Mention, November 2020.

II Patrycja Zdziarska, Felix Anand Epp, Walther Jensen, Mark D. Gross, and Ellen Yi-Luen Do. Hooze: A Kinetic Fashion Accessory for Touch and Play. In *Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '19)*, Tempe, AZ, USA, ACM, New York, NY, USA, 407–413, March 2019.

III Felix Anand Epp. Expressive Wearables: Practices-Oriented Codesign for New Forms of Social Mobile Technology. *International Journal of Mobile Human Computer Interaction*, 11, 4, 15 pages, October 2019.

IV Felix Anand Epp, Ilyena Hirskyj-Douglas, Andrés Lucero, and Tapio Takala. Identity through Social Wearables: Designing with Finnish University Students. In *Proceedings of the 11th Nordic Conference on Human–Computer Interaction: Shaping Experiences, Shaping Society (NordiCHI '20)*, New York, NY, USA, article 44, October 2020.

V Felix Anand Epp, Anna Kantosalo, Nehal Jain, Andrés Lucero, and Elisa D. Mekler. Adorned in Memes: Exploring the Adoption of Social Wearables in Nordic Student Culture. In *CHI Conference on Human Factors in Computing Systems (CHI '22)*, New Orleans, LA, USA, ACM, New York, NY, USA, 18 pages, April 2022.

Author's Contribution

Publication I: "Collocated Sharing of Presentations of Self in Public Settings"

The primary author of the first article is Epp, who conceived the study, designed the research protocol, collected the interview and observation data, and prepared the initial manuscript. Co-authors McGookin and Hirskyj-Douglas provided critical feedback and suggestions throughout the study's design and implementation. With Epp and Karyda collaborating on the data analysis and contributing equally to interpretation of the results, Lucero and Hirskyj-Douglas supplied additional insight. In addition, Hirskyj-Douglas provided substantial input for the writing of the manuscript.

Publication II: "Hooze: A Kinetic Fashion Accessory for Touch and Play"

Authors Zdziarska, Epp, and Jensen collaborated equally to articulating the research objectives, designing the study, implementing the experiment setup, and analysing the results. In particular, Epp was responsible for conducting the field evaluation and for implementing parts of the hardware prototype (1/3 in all) and most of the software (90%); also, Epp contributed 20% of the writing input. Throughout the study, Gross and Do provided critical feedback and suggestions.

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

The research reported upon in the article was conducted in accordance with what is presented in publications I and II. For this paper, Epp conducted the literature review, proposed following a design-research approach, and wrote the manuscript.

Publication IV: "Identity through Social Wearables: Designing with Finnish University Students"

Acting as the primary author of Publication IV, Epp planned the study, conducted the ethnography-based fieldwork, and handled the data collection (through participatory workshops) and analysis. Contributing to the study design, Lucero and Hirskyj-Douglas assisted in planning the co-design activities, while Hirskyj-Douglas and Takala supported the analysis of the results.

Publication V: "Adorned in Memes: Exploring the Adoption of Social Wearables in Nordic Student Culture"

As the primary author of this article, Epp was responsible for planning and conducting the study – inclusive of its co-creation process, the diary-based study and interviews, and analysis of the results – while Lucero contributed to the study's design. In addition, Epp implemented the software and hardware for the prototype. Together, Epp and Jain conducted the participant observation and analysed the data, while Kantosalo and Mekler contributed to the interpretation of the results. All sections of the article were written by Epp, with Mekler contributing to expression of the theoretical concepts.

Language check

The language of my dissertation has been checked by Anna Shefl (of Alba Saga Digital Freelance). I have personally examined and accepted/rejected the results of the language check one by one. This has not affected the scientific content of my dissertation.

List of Figures

List of Tables

Abbreviations

AR Augmented Reality

CSCW Computer-supported co-operative work

HCI Human–computer interaction

RQ Research question

RtD Research through design

1. Introduction

The role of clothes often gets sidelined as merely giving comfort to our bodies and protecting them from the elements. However, adorning our bodies with layers of clothing and embellishments is visible across all human cultures and even extends to non-human animals. Hence, we can well regard clothing and adornment as the ultimate social technology, with the phenomenon's magnitude being illustrated well in a short story by Gottfried Keller titled 'Kleider machen Leute'[1], the name of which references the Latin proverb 'Vestis virum reddit' ('clothes maketh the man'). The tale is of journeyman tailor Wenzel Strapinski, who, despite being penniless, is dressed in an expensive fur coat upon arrival in the Swiss town of Goldach. By dint of his appearance, he is mistaken for a Polish count, and his insecurity leaves him trapped in this lie and fully committed to it when he falls in love with a local woman. The story paints an evocative depiction of how people spin the story of a putative foreign count from mere appearance-based first impressions.

In his seminal description of dress cultures, Simmel (1905) describes adornment as expression of personality, where ordinary clothing fulfils utilitarian functions while adornment, in contrast, expresses the ownership of personality (1908, pp. 367–368). While his work employs the German concept of *überflüssig* for the latter, which is rendered as 'superficial' in its English-language version, the literal translation 'superfluous' is more faithful to the original idea: adornment as an addition to clothing creates an excess or surplus that overflows and consequently transports the meaning of personality. This still rings true in the words of Barnard (2014, Ch. 8) a hundred years later:

> The public sphere of modernity, with its cities and rootless crowds, relates to the private, one's innermost self, via what one wears.

[1] From the 1874 third volume of his *Die Leute von Seldwyla*, pp. 7–83, published by Göschen and available at https://de.wikisource.org/wiki/Kleider_machen_Leute.

As a practice essential to our social life, adornment uses our appearance to express and present ourselves to others (Goffman, 1959; Wilson, 2003). People control their behaviour and appearance so as to manage the impressions formed of them. This is necessary for developing human relationships and identity (Leary & Kowalski, 1990). Accordingly, the choice of clothing in its social context expresses one's membership of a social group (Tamminen & Holmgren, 2016). Considering this in light of wearable-technology research, which has aimed to make computing devices more portable, proves revealing. Looking at the meaningfulness that clothing holds for us humans leads us to ask what happens if computing becomes part of our social self, when it grows interwoven with the fabrics of society, literally. We can conclude that wearables and smart garments sit at a critical intersection since clothing is inherently social. This consideration underpinned my desire to contribute to our understanding of exploiting that potential.

Figure 1.1. Diana Dew's motorbike jacket from 1968 (Courtesy American Craft Council Library & Archives)

.

1.1 The Background and Research Environment

Exploration of wearable technology that augments appearance extends at least as far back as the 1950s and 1960s (Ryan, 2014). For example, Diana Dew experimented with electroluminescent clothing and integrated displays such as those in Figure 1.1. The human–computer interaction (HCI) field boasts a long tradition of research into supporting or enhancing

our collocated social interactions (Olsson et al., 2020). While much of the work has relied on mobile communication and multi-user interfaces, wearable technology was used very early on, as the pioneering Bubble-Badge display attests (Falk & Björk, 1999). Over the last two decades, HCI and design research have probed various forms of expression manifested by wearable technology (Berzowska, 2005; Genç et al., 2022). Progress with smart textiles, ubiquitous computing, and robotics has led to visual (e.g., Berglin, 2013) and kinetic (e.g., Kao et al., 2017) ways to augment human appearance. The augmentations get exhibited via garments (e.g., Devendorf et al., 2016), accessories (such as jewellery; see Inget et al., 2019), cosmetics (on interactive tattoos, see Kao, 2021), extensions to the body (such as a tail, per Svanaes & Solheim, 2016), and augmented-reality overlays (e.g., Mackey et al., 2019). These wearable augmentations have been studied as active augmenting of our face-to-face interactions by means of wearables (Dagan, Márquez Segura, Altarriba Bertran, Flores, Mitchell, & Isbister, 2019) that support people's work (e.g., in relation to offices' break time; see Dagan & Isbister, 2021) and leisure activities (such as running, per Mauriello et al., 2014). Alongside issues related to sensing the users and their environment, actuating feedback, and how sensing and actuation may best interact, the research has identified socially related requirements for wearables' design. Studies of technology for collocated social interactions have evaluated social context primarily via the lenses of acceptability and privacy (Olsson et al., 2020). L. Dunne et al. (2014), described that the social-acceptability concerns of wearables encompass aesthetics, social identity, and cultural norms. Further, matters of privacy and control constitute a ongoing concern in users of novel wearable technology (Toussaint & Toeters, 2020).

While such groundbreaking work has produced deeper knowledge that can ground wearable design for augmented human appearance, most consumer products in this domain are restricted to health-related use cases (Jarusriboonchai & Häkkilä, 2019). While novel fashion-oriented and social wearable products have emerged (Charara, 2016; Collective, 2018; Liber8tech Team, 2018), alongside plenty of spectacle in the arts and fashion world (Dagan, Márquez Segura, Altarriba Bertran, Flores, Mitchell, & Isbister, 2019; Mackey, 2021; Ryan, 2014), widespread adoption in everyday wear has yet to materialise.

To advance attachment to such devices, scholars have urged designers to embrace fashion that goes 'beyond the utilitarian and functional level to achieve self-identification and self-representation' (Pan et al., 2012). However, in the intervening span of nearly two full decades, reactive fashion has not emerged as the 'killer app' (Berzowska, 2005) of wearable computing. Recent years have seen design scholars explore experiences of wearing technology from an aesthetic, performative, and material- and fashion-centred perspective (Mackey, 2021; Toussaint, 2018; van Dongen,

2019), yet a central question remains: how to integrate the technological functions with the social function of clothing and, thereby, cultivate widespread adoption (Genç et al., 2022).

Via their extensive review of literature on collocated social interactions, Olsson et al. (2020) laid bare this extensive corpus's inattention to the social context. Apparent neglect for such analysis is evident in investigations of everyday use and of how this hybrid space of collocated social interactions and interactive technologies gets shaped (e.g., Nelimarkka et al., 2018). Hence, Olsson and colleagues called for 'more profound sociological and social-psychological analyses' and for scholarship that, by targeting specific social settings, stretches 'beyond the classroom, corporate or event contexts' (Olsson et al., 2020, p. 36). Indeed, some recent explorations of dynamic fabrics have highlighted the value of considering performativity and 'exploring genuine social contexts within personal clothing practices' (Mackey et al., 2017).

1.2 Project Aims and Scope

Combing through related work reveals plenty of explorations of novel formats suited to augmenting appearance with wearable technology. However, integrating new expressive technologies into people's current practices remains tricky both for wearable design and for technology aimed at collocated social interaction. At this juncture, I should stress that, because the dissertation is oriented toward routine use, I steer clear of applying the term 'appearance' for any attribute. Instead, my focus is on adornment as an active process. Furthermore, I avoid referring to the practice by the term 'fashion', so as to avoid confusion with high fashion as one particular form of the larger social construct. Having identified a gap both in the adoption of social wearables and in associated scholarship, I formulated the following aims for the doctoral project:

> The research examines how augmentation of adornment shapes social practices and, thus informed, sets out to identify guidance for design that encourages adoption of expressive wearable technologies.

In line with this general aim, less attention was devoted to solving a particular problem of acceptability or privacy; focusing on those limiting factors could have posed a risk of distracting from the constantly shifting dynamics of social life (von Terzi et al., 2021) and diminished the contribution to understanding wearable technology from the angle of social practices. The latter objective requires a horizon beyond user–device interactions or users' relationship to sensor-tracked data. 'Zooming in' to consider the dynamics of day-to-day social life enabled me to focus on practices as the

unit of analysis and as the starting point for any design activities (Kuijer, 2017).

Because the literature on fashion and collocated social interactions recommends studying technology in natural social settings, it is aligned well with practice scholars' call for examining practices in the field (Kuutti & Bannon, 2014) and for observing the 'mess' of life in the real world (Dourish & Bell, 2011). Therefore, the doctoral project investigated people's existing adornment practices in the context of three cases in Finland. Firstly, an expansive case study looked at opportunities for sharing personal sketches on clothing in public spaces in urban areas, with a second explorative study focused in on a zoomorphic accessory for eliciting attractive social touch. The final case study, which proved to be the most illuminating, investigated a striking tradition in which Finnish university students wear and adorn boiler suits. Over the course of two years, the research team studied their adornment practices and, by following a practices-oriented design process, strove to capture transformations through design interventions. subsection 3.1.1 elaborates on the case studies.

1.2.1 Research Questions

The discussion addresses the following research questions, through which the case studies dealt with the overarching question presented above.

RQ1: Which elements structure augmented adornment practices?
To understand the practice of adornment, one must tease out what constitutes that practice and the role of digital technologies in it. Detailed description of the various structural elements aids in identifying entry points for design and for embedding expressive wearable technology in the various practices.

RQ2: How do digital technologies contribute to the transformation of adornment practices?
Social practices change over time, and digital technologies influence the changes. In the case of adornment, the paucity of adoption cases had left a knowledge gap with regard to such dynamics. Looking at specific cases of changing practices should shed light on the influence of digital technologies. Such insight could hold significant potential for anticipating adoption processes. As the final case study clearly illustrates, technology already plays a role in student adornment.

RQ3: Which design approaches can propel wearable technology's adoption and routinisation in adornment practices?
The gap in current literature on designing wearables for augmenting face-to-face social interactions amply illustrates the need for greater guidance on advancing adoption of the associated technologies. Together, prior

knowledge and the empirical findings from considering RQs 1–2 must be translated into adoption-related design knowledge.

Table 1.1. Which publications and chapters address which research questions.

Research question	Chapters	Publications
RQ1, on elements of adornment	4, 5	I, II, IV, V
RQ2, on adornment dynamics	5	II, IV, V
RQ3, about design approaches	6	I, II, III, IV, V

Because of the limited adoption of wearable technology for expression, answering those questions requires research through design (Koskinen et al., 2011; Stappers & Giaccardi, 2017; Zimmerman & Forlizzi, 2014), through which we can evoke and observe people's practices of engaging with technological artefacts. With the doctoral project, I sought to design technology-mediated experiences with relevance for the cases at hand. Table 1.1 presents an outline of how the publications and chapters function together to address the set of research questions.

1.3 The Structure of the Dissertation

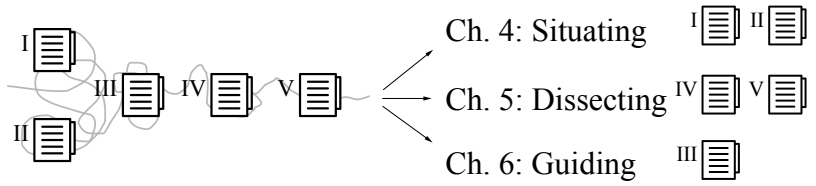


Figure 1.2. The structure of the project's outputs, with the publications focusing on a specific process and the individual chapters attending to situating, dissecting, and guiding augmented adornment.

To answer the questions posed, I proceed by reviewing the literature and theoretical perspective, describing my methodology, and presenting the research conducted in the three case studies as presented in the five publications.

I devote Chapter 2 to the theoretical foundations for this research. The chapter explains the current limitations and what guidance does exist for designing wearable technology for social interactions. From that starting point, I present the advantages of viewing these technologies as part of the social practice of augmented adornment.

Within this theoretical framing, I formulate a detailed description of the methods followed in my work, in the following chapter (3). Thus, I highlight how the empirical approach of research through design was employed to offer a perspective oriented toward the dynamics of adornment practices,

and I clearly pinpoint the scientific and designerly methods used to address the research questions.

The subsequent three chapters (4, 5, and 6) present the results reported upon in the publications. They cover the empirical work behind publications I, II, IV, and V and also present a proposal for a solid approach to designing expressive wearables, based on the literature review in Publication III. Figure 1.2 represents the process as synthesis centred on a coherent approach followed comprehensively via multiple case studies.

Applying a research-through-design process, the studies behind the first two articles aided in scoping the breadth of considerations that are crucial for designing expressive wearables, which I describe in Chapter 4. The first study, exploring self-expression with an outward-facing view across numerous contexts and personal realities, revealed distinct routines of how people go through their day. Thereby, it revealed how presenting the self by means of an expressive wearable artefact is best understood through the lens of everyday activities. In contrast, the second article explores self-expression reflectively, thus offering an internal perspective on designing and evaluating a social wearable to support social touch. With Publication II, reflections on our own subjective experience helped to understand how an artefact becomes part of the social practices that unfold between individuals.

The final two articles (publications IV and V) illustrate an approach to designing specifically for the context of adornment in Finnish student culture. In Chapter 5, I attend to the illuminating case of boiler-suit adornment and how the students' practices changed when digital materials entered the augmentation arena. For Publication IV, I immersed myself in the relevant cultural practice and present students' aspirations and what potential they see in expressive wearable technologies based on speculative design concepts. For the final publication, I employed a dedicated process for designing an artefact with the students, thereby examining their situated augmented practices via a field study.

With the last chapter addressing the project's results (Chapter 6), I synthesise the findings from the design process outlined in Publication III and offer reflections in light of the descriptions from Publication IV and Publication V. On that basis, I then propose an open-ended, practices-oriented approach for generating intermediate knowledge. Proceeding accordingly, my conclusions articulate the robust concept of Memetic Expression (introduced in Publication V) as an illustration.

The final chapter of the dissertation summarises the findings from the project; discusses the doctoral research's implications for theory and practice; and discusses positioning, generalisability, and the prospects for future endeavours.

2. From Wearable Computing to Augmented Adornment

Interest in wearable technology and smart garments has grown over the last two and a half decades. For all this time, researchers explored digital means of supporting social life with these technologies. As such, their efforts overlap with social computing in its interest in social interactions between people who share the same space at a given time (Olsson et al., 2020), in what are often called collocated social interactions. The roots of this dissertation lie in early work that not only explored wearables (Falk & Björk, 1999) but used public displays (McCarthy, 2002) more broadly. Since my project focused in particular on how technologies can extend the social functions of dress, I begin the discussion by characterising the literature on approaches to social functions augmented with technology, the state of the art of augmenting appearance, and the associated design knowledge accumulated thus far. Later sections of this chapter explore theory-based frameworks that aid in investigating what I call augmented adornment and, in turn, guiding it. This entails drawing a bridge from Erving Goffman's descriptions of self-presentation, to which HCI scholars often turn for guidance, to other performative perspectives and, finally, modern social-practice theory, with a look at fashion studies.

2.1 Wearable Technologies and Social Interaction

The most in-depth evaluations of collocated social interaction over the last three decades have been designed for public consumption (Ludvigsen, 2005, 2006). Much of this work has been focused on events, mainly associated with education and conferences (Chen & Abouzied, 2016; Nelimarkka, 2018). For instance, connecting to nearby mobile devices can facilitate collaboration to complete tasks, socialise, or have fun via activities of various sorts (Jokela et al., 2015). While most efforts have been pinned to a distinct use context, wearable technology itself is free of any specific local context, as it travels with people through their multifaceted day-to-day life (Jumisko-Pyykkö & Vainio, 2012). The devices too rarely are single-

purpose items; through the corresponding device ecosystem (Grubert et al., 2016), wearable technology functions similarly to clothing, fulfilling its function as it engages with day-to-day life. Recent studies have explored a baseball cap that shares users' activity data throughout two weeks of their routines (Colley et al., 2020), nine months' use of digitally augmented clothes assisted by 'macro keying' and social-media-based sharing (Mackey et al., 2017), and a novel augmentation of the human back for social distancing at a shopping centre (Pakanen et al., 2022). However, few commercial wearable products exploit the potential of interacting with nearby people. Most products that exist are restricted to health-related use cases (Jarusriboonchai & Häkkilä, 2019).

2.1.1 Augmenting Social Interaction

Research into wearables often focuses on sensing and collecting data, processing said data as input to modelling and prediction, and then informing or augmenting human capabilities. This approach to augmenting/enhancing humans' actions via technology is reflected in the inroads to computer-supported cooperative work (CSCW) on technologies for collocated social interactions. Summarising these technologies' techniques under the categories of enabling, facilitating, inviting, and encouraging social interactions, Olsson et al. (2020) concluded that most of these perspectives approach computation as a form of control of our social interactions. At the intersection between technologies aimed at enhancing social interactions and wearable computing sit social wearables, 'worn on the body [to] augment co-located interaction' (Dagan, Márquez Segura, Altarriba Bertran, Flores, Mitchell, & Isbister, 2019). Dagan and colleagues (2019) categorised the wide range of approaches into 'augmenting existing social signalling' and 'proactively intervening in social situations'. One example of recent efforts in the former is the work by Pakanen et al. (2022), who used a shape-changing origami system on a wearer's back to reinforce established social signalling of the need to keep one's distance during the SARS-CoV-2 pandemic. The latter less-explored category entails a systems design by Dagan, Márquez Segura, Altarriba Bertran, Flores, and Isbister (2019) whereby dependencies created among collocated participants spark actions. In this 'True Colors' system , live-action role players wear a device around the upper body that renders them vulnerable such that another player must resolve the situation. This two cases already illustrate the range of variety in how social wearables can involve the wearer, the spectator, or both and reconfigure the relationships between them.

2.1.2 Augmenting Appearance

Addressing the research questions required me to consider all forms of personal expression. While some individual-level ones are not aimed at signalling social cues to a spectator, they still communicate a person's inner experience (Bruner, 1986) and, thereby, become part of the social being. In the subsequent section, I describe in more detail how we can see this as an integrated process of self-identification. But first, with this broadened perspective on wearables that augment human social interactions I identify various forms of ubiquitous technology that enrich appearance. Genç et al. (2022) recently typologised such technologies in terms of five distinct layers associated with the body.

In the first category, that of **accessories**, fall the technologies we associate most closely with *wearables*. The first definitive explorations of these, in the 1990s, built personal badges (Borovoy et al., 1998; Falk & Björk, 1999), and the proliferation of smartwatches later led scholars to investigate those devices' potential as public displays (Pearson et al., 2015). Recent research has examined accessory-based approaches tied in with various traditional accessories, among them bags (Colley et al., 2016), hats (Colley et al., 2020), and jewellery (Rantala et al., 2018). Although handheld devices are not worn on the body, some applications relying on mobile phones' and laptop/tablet computers' external displays (Jarusriboonchai et al., 2016; Kleinman et al., 2015) can be regarded as altering a user's appearance.

The second category, **clothing** and textiles, covers all forms of smart garments that humans use to clothe the body. While HCI researchers have experimented extensively with integrating various kinds of displays into garments (Dierk, Nicholas, & Paulos, 2018), fashion designers have looked most extensively at LEDs (for discussion of an extensive array, see Mackey, 2021, Ch. 2). That said, recent explorations have extended attention further, to the fabrics' aesthetics and material qualities. To this end, scholars have examined light-emitting fibres (Sayed et al., 2010) and thermochromic dyes (Devendorf et al., 2016).

One of the oldest adornment techniques is direct application of pigments to or within the body. Recent decades have witnessed augmented makeup and tattoos employed to support **artificial skin and appendages** (Kao, 2021). Glowing or even moving hair and wigs (Brun & Häkkilä, 2021; Dierk, Sterman, et al., 2018; Lee, 2018) have attracted attention for their potential to extend the expressiveness of our appearance.

The versatility of these traditional dress layers notwithstanding, modern technology has unveiled new layers. With attachment of **artificial body parts**, humans can manipulate a tail, additional ears, or more arms (Svanaes & Solheim, 2016; Xie et al., 2019). While simply sporting additional body parts already extends the wearer's look, these devices allow

(a) **(b)**

Figure 2.1. Left, a self-portrait of Steve Mann wearing his inventions MindMesh (wearable computing for Brain-Computer-Interaction) and EyeTap (AR glasses with high dynamic range)(wikimedia.org[1]); Right, Phem, a fashion garment with an AR layer Angela Mackey (phem.design[2]).

the wearer to signal to others with a gesture imitating or reinventing non-verbal communication.

The final layer, another technology-driven additional one, is called the **digital aura**. Scholars have experimented with mobile projections (Ng & Sharlin, 2010) or augmented reality (AR) to extend clothing and appearance (Häkkilä et al., 2017; Hirskyj-Douglas et al., 2019; Mackey et al., 2019), such that human appearance can transcend the physical body. However, many of these technologies remain disconnected from bodily adornments.

The spectrum of expressive technologies stretches across all layers of human appearance. In recent technology- and fashion-inspired endeavours, engineers, designers, and artists have pushed the boundaries of what people can express with their adorned bodies. Just as the first forays into wearable computing manifested 'geek chic' or sci-fi aesthetics, as illustrated in Figure 2.1a, many studies still are techno-centric. This tension of the field necessitates examining precisely which theoretical understandings have gone into describing and designing technologies for adornment. The following portions of the chapter speak to this aim.

[1]CC BY-SA 3.0, https://commons.wikimedia.org/wiki/File:MannGlassEye_and_MindMesh_2427-2429proc_rotated_cropped.jpg

[2]2019, CC BY-NC 4.0, https://phem.design/photo-gallery

2.2 Performing Identity with Wearables

A large body of literature on wearable technology provides a knowledge base for examining user experience or *wearability* (e.g., Dibia, 2015; Häkkilä, 2017; Zeagler, 2017). In work on social technology, the design of social wearables revolves around the interplay of actuation, sensing, and collocated users (wearers and non-wearers alike) (Dagan, Márquez Segura, Altarriba Bertran, Flores, Mitchell, & Isbister, 2019).

The design of wearable technology, even if not directed toward social interactions, is unique in that it is bound up with the existing functions of dress. As I have already highlighted, social functions are among these. For more than a decade, scholars concentrated their efforts on questions of social acceptance and adoption (L. Dunne, 2010). After all, the main barriers beyond functionality issues in the technical domain (such as durability) are related to identity and aesthetics (L. Dunne, 2010; L. Dunne et al., 2014).

2.2.1 Self-Presentation and Social Acceptability

In the HCI discipline, the prevailing theoretical perspective for explaining social factors in interactive computing systems is rooted in Goffman's (1959, 1966) concept of self-presentation. At its heart lies the metaphor of a theatre performance: interpersonal interactions in public can be likened to performances facing an audience. Through performance, individuals try to cultivate and maintain a particular impression of themselves in others. This impression management (Leary & Kowalski, 1990) is centred on how the performer acts on the basis of an ideal presentation of self coupled with spectators' reactions. Technology is inextricable from one's performance, so it is technologically mediated performances that the spectators and performers scrutinise.

Digital technologies have brought a dramatic shift in the way people communicate and perform the self online, with the advent of computer-mediated communication, most visibly social media and online social networks. While social-media platforms, Instagram among countless others, have become fundamental to how adolescents develop their social identity today (Xiao et al., 2020) and with social matching services having become prevalent (Mayer et al., 2016), some dynamics have emerged that lead to isolation and loneliness (Turkle, 2012). Most strikingly, several of the platforms require presenting a uniform persona, which clashes with common practices of playing different roles for different people (Farnham & Churchill, 2011; Van Dijck, 2013).

In recent renewed efforts to address the social acceptability of interactive technologies, the HCI discipline has directed attention especially to those designed for public use, such as wearable displays and other expressive

technologies (Koelle et al., 2020). For example, others' gestures prompted by wearable devices can leave the wearer ill at ease (Profita et al., 2013; Rico & Brewster, 2010). The mediated content and the device's aesthetics are critical factors in physical appearance. Research with thermochromic textiles Devendorf et al. (2016) found that people overlook certain aesthetic aspects of wearing digital screens because of the encounters' transitory nature – i.e., the fast pace of the images' presentation dictates that no image is present for long. Some may find that very pace disconcerting, though. Moreover, the aesthetics of a social wearable might run counter to a wearer or observer's gender identity (Dagan, Márquez Segura, Altarriba Bertran, Flores, Mitchell, & Isbister, 2019). Even some positions on the body may be eschewed, in light of such factors as sexual connotations; for instance, some women may not wish to draw attention to their chest area (Zeagler, 2017).

Figure 2.2. The Idle Stripes shirt (right) was studied for everyday wear, e.g. in the workplace (left) without raising any concerns about social acceptability (©Harjuniemi et al., 2018, Harjuniemi et al., 2020)

Still, scholars have repeatedly stressed that the cultural context and social environment change the constellation of norms around acceptability (Dagan, Márquez Segura, Altarriba Bertran, Flores, Mitchell, & Isbister, 2019; L. Dunne et al., 2014; Genç et al., 2022; Kelly & Gilbert, 2016; Profita et al., 2013). For example, the above-mentioned concerns about wearables' use in the chest area were not identified in the garment in Figure 2.2 that displays activity information (Harjuniemi et al., 2020).

Designers continue to face the complex question of which strategies support acceptability and adoption. Social acceptability depends on both the negative and the positive effects of the technology (Kelly & Gilbert, 2016). For social acceptability, Koelle et al. (2020) conclude, that designers might be well advised to focus on building products whose pleasing aspects outweigh any negative connotations and therefore digital functions and aesthetics should stay unobtrusive.

Again, however, acceptability and norms are far from static. Norms evolve through the negotiation processes cross-cutting all of our social interactions and performances. On this basis, HCI scholars have acknowledged self-presentation as an iterative process that is moulded through a

person's capabilities and the diverse 'social and cultural expectations' of audiences (Koelle et al., 2020, p. 2).

Upon reviewing the literature on studies of technologies that support social interactions, Olsson et al. (2020, p. 36) called for deeper analysis of the social and social-psychological processes in play. They found that researchers rarely focused on the social context or on how practices unfolding between people and technologies get shaped (Olsson et al., 2020, p. 36). From another angle, L. Dunne et al. (2014) asked whether technologies can support this negotiation process. Nonetheless, the frameworks introduced thus far (Dagan, Márquez Segura, Altarriba Bertran, Flores, Mitchell, & Isbister, 2019) are unable to guide design decisions comprehensively toward such supportive interaction and findings on using ambiguity call for further investigation into representation and interpretation (Howell et al., 2018). Instead, recent years' research into social wearables has identified distinct general design concepts, 'strong concepts' (Höök & Löwgren, 2012) that are valid beyond any specific context (Dagan & Isbister, 2021; Isbister et al., 2017). In other findings, Devendorf et al. (2016) recommends ambiguity in visual aesthetics – leaving room for interpretation. It appears thatthe dynamics and complexities of people's performances have been neglected, and few guidelines exist to aid in designing for the adoption of expressive wearable technology.

2.2.2 The Performative Turn

While managing impressions is vital for forming relationships in either one's professional or one's private life (see Leary & Kowalski, 1990), the strategy of making technology subtle so as to guarantee social acceptability conflicts with the goal of proactively influencing social interactions and adornment. While Goffman's observations on self-presentation have been discussed critically and refined for more than half a century now, they remain a linchpin of the HCI discipline. One point of criticism might even explain their perennial popularity: most of his observations focus on detached series of episodes from interactions rather than on life as 'continuous and developmental' (Garfinkel, 1984, p. 167, as cited in Raffel, 2013, p. 166). In this, they mirror the HCI field's own approach.

In a further twist, Goffman never offered a clear definition of the self in his writings (Manning, 1992). Therefore, his metaphor might well accentuate the disparity between the performance presented and the performer's authentic internal state. To tackle this issue, Schlenker (1986, p. 23) added another process to the picture: performing self solely to reflect or create an image of oneself, not directed at an audience. For example, the logic of the statement 'I have to prove this to myself' may be very familiar. Schlenker brought together this process and self-presentation under the umbrella of 'self-identification' as an interdependent continuous process.

Scholars engaged in science and technology studies have shifted their focus lately from examining predetermined symbolic structures and texts to considering how individuals actively construct reality. Consequently, these researchers today regard any social action as a performance and apply their analysis tools accordingly. This 'performative turn' expresses the suggestion that all human practices can be taken to be a public display of the self (Toussaint, 2018, p. 149). Entwistle (2015, p. 97) has argued that modern subjectivity is closely intertwined with forms of dress, as identities are expressed through presentations of the body. To study this perspective as wearable technologies enter the scene, some scholars employ the term 'techno-fashion' (Mackey, 2021, p. 25). Techno-fashion is seen as unique in how it mediates meaning in both a material and an embodied sense (Toussaint, 2018):

> Techno-fashion [. . .] exerts influence over wearers and their social relationships because it acts both as an immaterial carrier of meaning (i.e., involving signs and symbols) and as a material thing (i.e., involving bodily, technological and textile matter).

From Goffman's theatre analogy, the performative turn in sociology, and materialist phenomenology, we can conclude that adorning is a performative act. Applying the notion of appearance for some static description of someone's character leaves too narrow a window for grasping the dynamics of people's self-identification process. On the other hand, peering only at episodic face-to-face social interactions discounts the material performance of adornment, which characterises and constantly conditions the relationship between wearer and garment.

It is in this light that we need to consider designers' aim to 'bring meaning to individual, as well as social experiences' (Tomico & Wilde, 2016), with a focus on fashion-centric elements such as materials, bodies, and social context. Consequently, how these factors contribute to emerging meaning takes centre stage in the ongoing enquiry pursued in this branch of research (Tomico & Wilde, 2016).

A crucial unanswered question is that of the connection of these relational perspectives (between wearer and spectator, between wearer and garment, etc.) to larger structures of human behaviour. Processes such as adoption go beyond the individual's subjective construction of reality. I introduce the contemporary theories of social practices built on performances in the next section, to provide a framework for articulating what links individual-level performances to performances that span populations and entire societies.

2.3 Practice As a Unit in Design

As scholars of HCI have argued (Rogers & Marshall, 2017), traditional theories of cognition (situated, distributed, and embodied) are insufficient for grasping the complexity of everyday activities in the wake of digital services' expansion to ubiquitousness. Therefore, a situated approach to research into human–computer interaction should yield insight that represents more than merely ecological validity. Suchman's (1987) seminal work – with its primary framing of 'situated actions' standing in contrast against the predominant model of planned action – was highly influential in bringing an ethnomethodological perspective on human actions to the HCI discipline. In other relatively early work, Wynn (1991) proposed *practices* as a fitting lens for ethnographic research or case studies. The past decade has brought Kuutti and Bannon (2014, p. 3550)'s invitation for a paradigm shift, from *interaction* to *practice* as the unit of analysis. The resulting perspective should provide researchers with a tool for handling the interconnected digital ecologies that make up people's lives rather than focusing on the individual user (as HCI scholars tend to do) or the organisational structures (in the CSCW domain especially). The notion of context no longer can suffice for situating the interplay between humans and machines; it must become one integral aspect of the larger investigation, among many. While Kuutti and Bannon explained the 'turn to practices' with regard to a collection of theories applied in HCI work that take a practices-oriented approach, with one example being Suchman's ethnomethodology. I proceed from Kuijer's (2017; 2013) introduction of contemporary or 'second-generation' social-practice theories (T. R. Schatzki et al., 2001; Shove et al., 2012) for design.

Practices As the Unit of Analysis

Lenses oriented toward practices shift scholarly attention from explaining human action as rational, goal-driven actions to compassing routinised 'bundles of activity' (Bottero, 2015). Hence, practice theory provides not a model of causal relations but a framework via which we can generalise and abstract a particular aspect of human behaviour (Kuijer, 2017).

Therefore, contemporary social-practice theorists remove the individual from the centre of the picture. Instead, individuals operate as performers of a practice. The elements conventionally regarded as personal attributes – meanings, know-how, etc. – are constitutive of the practice (Shove et al., 2012, p. 7). While practices are built on these shared elements, they also get 'continuously replicated in the flux of human behaviours' (Sadkowska et al., 2015).

Practices are fundamentally social, even if only a single person carries them out (as is often the case in brushing one's teeth), for the practice itself is borne by indefinitely many people across society. Through their

routine performances, practices make up the structures of society (i.e., institutions of power, science, education, transportation, and other relations) (T. Schatzki, 2016). To differentiate individual-level behaviours from practices, Shove et al. (2012) distinguished between the notion of *practice-as-performance*, to denote a single occurrence (e.g., me using an electric toothbrush in the morning), and *practice-as-entity*, a concept for discussing a shared social practice (e.g., tooth-brushing).

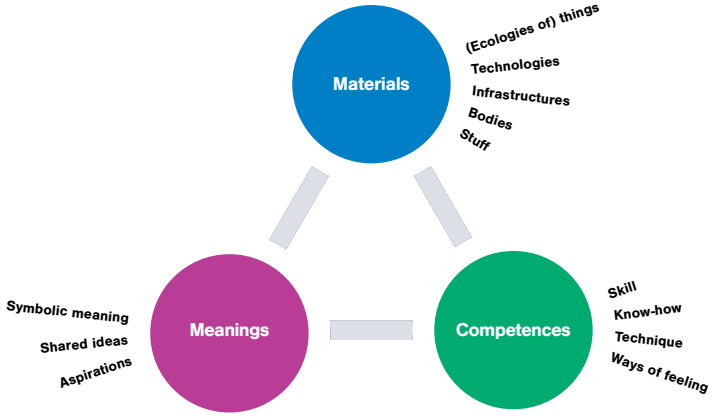


Figure 2.3. The three constituent elements of a practice (adapted from Kuijer et al., 2013).

Materiality, Meanings, and Skills As Components

Modern practice theories are highly suitable for examining innovation and design, as they align with the material perspective (Kuutti & Bannon, 2014). Today's practice scholars take the physical world as a fundamental element of practice. For example, T. R. Schatzki (2012) proposed many years ago that a practice, as a set of activities, and its material arrangements are fundamentally linked. They cited the example of the classroom, which is an arrangement necessary for teaching yet also shapes teaching of the way it is practised. Shove (2007), in contrast, referred to the example of bathing, which cannot exist without water. In their view on the design of everyday life, which I adhere to throughout this dissertation, materials are incorporated into practice as an essential element of it, in parallel with meanings and skills (or competencies, as in Figure 2.3). Materials form the foundational element of a practice. This is the 'stuff' of which the physical world is made, with things but also infrastructure and bodies. Secondly, competencies, such as know-how, techniques, and even ways of feeling, are essential to the performance of a practice. If we take the example of getting dressed, someone who has never worn Thai fisherman's trousers might struggle with the folding sequence that enables them to fit nearly any body size and shape without a belt or straps. The final component is meanings: shared ideas, such as values; the symbolic meanings intrinsic to

the practice; and related aspirations (e.g., hygiene-related norms connected with bathing).

Innovation As Reconfiguration of Elements

Changes in practices, and consequently in society in general, occur when links between elements change. For design and innovation, one can introduce new materials or meanings but ultimately link these together to form a new coherent practice. For research and design, we can identify new possible links between elements as *proto-practices* (Shove, 2007, p. 24). While a new constellation might be formed once, human action becomes a practice only once the links between all of the elements stabilise (Shove, 2007) in at least temporary equilibrium. For example, video calls' availability in connection with limitations on physical collocation enabled the practice of remote teaching to coalesce during the recent pandemic. With the removal of physical distancing measures, remote teaching then evaporated in most places, while other forms of hybrid work, such as hybrid conferences, seem to have stabilised.

Design can transform practices by contributing to expression of all three core elements: the product language can incorporate new meanings, novel artefacts or infrastructure may add materials, and instructions offer support for new skills (Kuijer et al., 2013). While digital technologies can play a physical material role in practices, we must also consider their digital materiality. Indeed, many scholars have argued that software or computing can be understood as material in a design process (Leonardi, 2010).

Simultaneously with such conscious efforts, unconscious appropriation might take place as preexisting elements are brought in from other existing practices (T. R. Schatzki, 2012, p. 23; Shove, 2007, p. 8). Often, technologies get incorporated into existing habits and routines in this way – e.g., in their manner of permeating family life. This implies that new technologies undergo transformation (while functioning in transformation) and that 'domestication' is not permanent but a continuing process. Products evolve as they are integrated into fluid environments of consumption, practice, and meaning, in that

> the dynamics of appropriation never end and [. . .] the (re)attribution of meaning is part of a continuous process of normalisation, and is as such not restricted to the first moments of innovation (Shove, 2007, p. 8)

However, the competencies needed to perform a practice can also change through the exercise of influence, as modern technologies support specialist skills that aid in transferring and transforming other practices. Innovation – i.e., adoption as the normalisation of a technological practice – is a continuous appropriation process. For any design to become adopted,

it must accommodate such a process. The work of Kuutti and Bannon (2014, p. 3550) proves illuminating in this regard: they highlighted the coevolution of practices and artefacts, with evolution rates varying practice-specifically. For instance, rigid links between interactive systems can hinder the adoption of novel practices.

2.4 Adornment and Fashion in Everyday Practice

In today's public discourse, the social functions of fashion and clothing seem obvious: to create distinction and display social status. While Bourdieu (2008) dealt with these delicately when presenting his work on French class distinctions, a perspective has emerged in recent decades that responds to the structure of post-modern societies. In these societies, fashion trends and meanings do not replicate divisions along social class lines as much as they demarcate a wide range of cultural groups and corresponding social identities. Particular youth cultures seem to influence trends that feed in to a larger reproductive fashion system (Entwistle, 2015, p. 135). This environment's delineation between social groups and even between individuals through their membership in distinct groups expresses and perpetuates the constant consumption and reproduction of symbolic meanings (Tamminen & Holmgren, 2016). The practices of that consumption and reproduction can be seen as 'role-playing' (Crane, 2000, p. 11) wherein individuals continually redefine themselves through new projections of identity. We can view such 'identity work', then, as a social practice by grounding it in the material world, analogously to how Bottero (2015) described the practice of personal genealogy, which entails rethinking identity by means of digital tools and data. In the case of adornment, the materials are garments and accessories, through which technological aesthetics and cultural values grow intertwined (Chang & Lin, 2020). Therefore, design must consider cultural values if it is to produce wearables that respond fittingly to personal aesthetics and identity.

The following working definition serves my aims with this dissertation: augmented adornment is a bundle of practices (T. R. Schatzki, 2012) built on existing skills in adorning that transform through the introduction of digital materials and associated meanings. Using fashion studies to frame and analyse the work presented, I will refer to adornment primarily as an active process of expressing our subjective experience with jewellery, clothes, or tattoos. Adorning also implies using embellishments to highlight a purposefully dressed body in its cultural context.

It bears reiterating that such an approach requires a situated understanding. In prior work placing a focus on situated evaluations, fitness-trackers and smartwatches have undergone extensive research. A long-term study of smartwatch use supplied a valuable starting point in attesting that

the participants did use the devices in question in their face-to-face interactions (McMillan et al., 2017). While numerous wearable technologies aimed at augmenting adornment have appeared over the last two decades (see Section 2.1), few have been studied empirically and even fewer *in situ*. While recent reporting on a long-term study of a hat-integrated wearable display for physiological data (Colley et al., 2020) identified several factors, such as valence, that appear to drive the use of this technology, clear gaps remain. Just as in prior studies, the social context and the performance aspect display ample room for greater understanding of everyday wear. The only in-depth study exploring techno-fashion in the realm of everyday clothing (Mackey et al., 2017) used augmented reality to create digital fabric overlays. That long-term auto-ethnographic work revealed hindrances that the digital mediation wrought with regard to self-expression. Looking to the future, Mackey (2021) described how textile and digital aesthetics might merge. Building on that insight, the next chapter highlights especially how situated methodology should extend our understanding of wearable technology.

3. The Methods and Cases

I have now laid the groundwork for an understanding of social wearables and digitally augmented appearances as technologies holding potential to change our social life and society dramatically. Against that backdrop, this chapter describes the methods employed to develop answers to the questions posed in Section 1.2, questions that presume adornment to be a social practice and wearable technology to be an element contributing to its change. I begin by explaining the enquiry approach: applying research through design (RtD) in multiple field-based case studies. Then, I present the primarily qualitative methods followed to collect and analyse the data in each of the studies contributing to this investigation.

3.1 Research through Design in the Field

For reasons elaborated upon in the previous chapter, I chose social practices as the primary unit of analysis. This decision is consistent with the 'ultimate goal' Kuutti and Bannon (2014) recommended for the HCI field: formulating a practice-focused research agenda so as to understand and facilitate practices' transformation and the emergence of new ones. My work hence is centred on enquiry into changes to practices in people's lived world. While the social sciences traditionally examine the present and the past, constructive design research and HCI offer unique tools for studying the future as it unfolds, with RtD (Koskinen et al., 2011; Stappers & Giaccardi, 2017; Zimmerman & Forlizzi, 2014) enabling us to construct novel experiences and learn from reactions and from reflections on those experiences. Thus, the method generates knowledge that extends beyond practical implications for design (Zimmerman & Forlizzi, 2014). Its application in HCI and interaction design, being anchored in Frayling's (1993) conceptualisation of research in the arts and design, follows a pragmatic empirical approach.

Because practices unfold in the real world (see Kuutti & Bannon, 2014), we must study practices where people enact them. Hence, for my research,

Table 3.1. The cases in summary

Articles	**Case**	**Artefacts**	**Participants, *n***
I	Self-presentation in public	Sketchable stickers	30
II	Social touch	A zoomorphic accessory	3 (a design group)
IV & V	Boiler-suit practices	An interactive cloth patch	$44, \lvert IV \cup V \rvert$

I chose an RtD variant developed to address a design process developing in the field. Field deployment of RtD has its roots in participatory design and user-centred design (Zimmerman & Forlizzi, 2014), methods wherein designers engage with users in a combination of design ethnography, participatory methods, and interventions set in case studies (Koskinen et al., 2011; Stappers & Giaccardi, 2017).

Publications I and II present two distinct cases that function as snapshots, while the case described in publications IV and V involves something more: an intricate process of practices-oriented design. Participant observation and ethnographic fieldwork fleshed out my understanding of adornment. Complementing these techniques with designerly methods, I encouraged imagination through speculation with participants. The final component, field deployments, equipped me to probe for details by means of observational and experimental research (Siek et al., 2014). Throughout, it was crucial to construct experience with technologies (Koskinen et al., 2011, Ch. 8; Sanders & Stappers, 2014) embodied in people's practices (via working 'wearable' prototypes). Mäkelä et al. (2000) furnished a blueprint for such efforts by exploring new practices linked to multimedia messaging and predicting portions of today's multimedia-oriented landscape of social media. Ideally, the wealth of understanding accumulated via RtD cases connects practical knowledge of actual design artefacts with theoretical abstractions. Thus, 'intermediate' knowledge for design (Höök et al., 2015) functions as a bridge and contributes to scholarship in its own right. For example, strong concepts, as characterised above, function across multiple fields of application, offering abstract patterns that can serve design work but equally telling us about design at the level of theory too.

The following subsections explain my choice of cases in more detail, then examine, in turn, the various methods applied in the doctoral research. Through the research presented, I studied several forms of adornment practices in the field. Table 3.1 outlines the three field studies and corresponding publications. The first two dealt with the extremes of the adornment spectrum, while the third study, which turned out to be the most fruitful for the project, looked at a distinct community of practice in depth.

3.1.1 The Field Studies

For Publication I, I visited six locations in a Nordic urban centre (the Helsinki metropolitan area) to observe practices there and to conduct *ad hoc* interviews designed to capture situations as they manifest themselves. This study collected a large set of experiences from participants in a Western urban environment. With an open-ended approach to personal information displayed on the body, that case study was agnostic to the forms and facets of adornment.

With a very different starting point, Publication II had its origins in a personal quest to challenge social norms. It delves into the specific case of expressing enticing signals to bring about social touch. The environment of a week-long workshop in Finland and its international participants constituted the bounds for this case. While the design was autobiographical in nature, the members of the research team enriched our reflections through experiences public settings.

What we learned from the initial exploration helped me situate augmented appearance in context and home in on a commensurate model based on contemporary social-practice theories. To dive more deeply into the transformative process of practice, I then identified a specific case of adornment that is rich enough to exemplify intertwined practices yet also bound to a community with which I could engage: for what turned out to be the central case for the doctoral project, I chose the local student population's traditions of wearing and transforming boiler suits. Being a doctoral student afforded me straightforward access to this adornment practice. One dynamic in particular made this an especially fitting context for examining fashion practices (as opposed to more conservative clothing practices, such as dressing for work in a formal environment): while it boasts a long history, it has changed greatly in recent decades and is a youth subculture by its very nature. Furthermore, the student-implemented adornments are explicit, rich ones with abundant connections to innovation, technology, etc. and at the same time tie in with other public spheres, such as clubbing.

These features rendered it ripe for design interventions and for opening the technology-adoption process to study. To address multiple aspects of this revealing case, I dealt with it in two papers: Publication IV reports on the ethnographic fieldwork conducted to deepen my understanding of the adornment practice involved and the opportunities for its transformation, while the project's final publication (V), reporting on an elicitation-diary- and observation-based study, represents seizing those opportunities via a design intervention with a technological artefact – i.e., shaping and capturing the emergent practices.

3.1.2 Practices-oriented Design and Openness

For any new strategies and solutions encapsulated in products to take hold, they must become embedded in practice – i.e., in people's day-to-day life and the ordering of society (see Shove et al., 2012, p. 12). Recently introduced frameworks intended for design of practices equipped us with some tools for the design process used in the research. Practice-based computing (Wulf et al., 2015) has its history in workplace studies focused on the complexity of organisational structures and on user-interface design. Secondly, proceeding from design for behaviour change and sustainability, Kuijer (2017) formalised practices-oriented design, a technique whereby practices serve not just as a unit for analysis but as a unit for design (Kuijer et al., 2013). The approach is intended to disrupt a practice by inducing changes to its constituent elements. It is articulated in terms of a two-step design process: designers analyse the relevant practice by studying its elements, historical accounts, and related practices; then, design interventions introduce elements – materials, instructions, etc. – to create the desired change and inspire reflection on it. This process pursues the desired change to behaviour by steering the practice in the direction envisioned. For instance, it might cultivate a more sustainable practice for bathing (Kuijer et al., 2013) or for keeping warm (Kuijer, 2017).

The RtD in my work was aimed not at a given outcome state but at understanding transformation processes. Concrete digital technologies for non-work-related purposes must yield experiences that people can connect with and appropriate, rather than purely zero in on ease of use and improved task-performance (Gaver et al., 2003). Especially with regard to social practices, the ultimate purpose becomes the core guiding concept (Wynn, 1991). Therefore, designers should consider the goals and motivation behind the novel technology carefully.

For our work, a participatory process determined the purpose for the design that would follow. We were able to turn to relatively new design approaches that, rather than being need-focused, build from the assets that communities bring to the process (Wong-Villacres et al., 2021). Similarly, a design that prioritises possibility over usability can elicit more connections between users and artefacts, of a more emotionally evocative nature (Desmet & Hassenzahl, 2012). Research into novel practices has recently made good use of design processes with an open purpose and set of goals (Sanches et al., 2019); for instance, grappling with the issue of the central purpose for a physiological tracking device has enabled capturing proto-practices that point toward possible future uses.

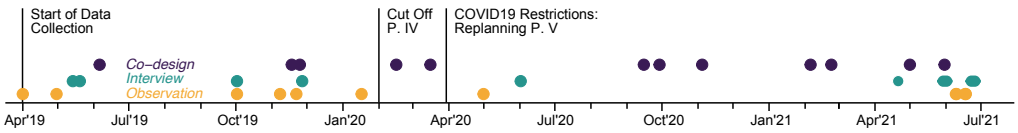


Figure 3.1. A timeline of the ethnographic field activities and co-design engagement.

3.1.3 Ethnographic Fieldwork

Developed in anthropology and other social sciences (for an outline of its history, see Dourish, 2014, pp. 4–12), ethnography has become an established method of fieldwork-based enquiry for design research and HCI. However, there are contentions that some HCI and CSCW scholars marginalise ethnographic fieldwork as 'requirement-gathering' (Dourish, 2014) and that a gulf remains because of designers' angle of approach to problems Khovanskaya et al. (2017). When designers can comprehend social and cultural context and when research puts design to use for exploring complex social issues, we can bridge even very wide gaps Khovanskaya et al. (2017). The recommended approach, dubbed design ethnography (Baskerville & Myers, 2015), combines anthropological and designerly traditions. Exercising it, RtD has made moves both to collect data for powering decisions and to create bodies of data covering the cases and life worlds with which RtD engages (Dourish, 2014). Ethnographic approaches may be especially valuable when the technology is not workplace-based: 'Designing for pleasure demands a different approach from designing for utility' (Gaver et al., 2004, p. 53).

Ethnographic fieldwork has been implemented in wardrobe studies within the fashion domain (Fairburn et al., 2016; Skov & Melchior, 2010) and HCI (Møller, 2018), where the aim is to integrate wardrobe pieces and wearable technology unobtrusively into day-to-day life (Horst et al., 2021).While the ethnographic fieldwork in the doctoral project was neither that narrow nor 'full-blown ethnography' (Jonathan Lazar et al., 2017, p. 235), it dovetailed well with my methodological underpinnings: case-based RtD studies. Still, it was crucial to remember that ethnographic fieldwork conducted with a practices-oriented design must contribute to understanding individuals in their specific social groups, their norms and practices beyond user experience, and contextual factors. The aim is not generalisation (Harvey & Myers, 1995).

The Case of Boiler Suits

Because the student traditions follow the academic year's rhythms, I carried out fieldwork for two years. Thus, the work encompassed a more than a full cycle. Employing snowball sampling, I began by conducting structured field visits dedicated to wardrobe practices. Alongside observations

from these, captured in reflective notes, I used in-depth open interviews with key informants. Once I had gained an overview and insight from this starting point, I followed one key informant to understand the dynamics of the practices. Continuously analysing the ethnographic data and through iterative reflection on my field notes, I honed my understanding and built a picture of the recurring themes, as reported in Publication IV.

3.1.4 Designerly Methods and Co-creation

Figure 3.2. Participants in one dialogue-lab session, with design pairs at separate stations.

Decades of RtD in the field and co-design of digital systems notwithstanding, participatory methods have been exploited only rarely in mobile-computing context, though they have grown more prominent recently (Stigberg, 2017). Because my objective was to examine and influence adoption and, through it, the manifestation of wearables in social life, I sought to address questions beyond utility in a product-oriented manner. Following practices-oriented design, the project was developed to design novel wearable technologies, for augmenting social interactions, that transform adornment practices as they grow enmeshed in those practices. Hence, it touched on such deep issues as what society is and how design creates futures.

In the case most central to my work especially, relying on co-creative design as collaborative research practice meant to 'learn from the collective creativity' of the community (Zamenopoulos & Alexiou, 2018). Its forms in the project ranged from collaborative design (for Publication II and for Publication V) to co-creation of the artefact Digi Merkki, the finished product presented in the final publication. While the design ethnography mentioned above enabled engagement with the living worlds of the com-

munity, we also included the participants as co-innovators. In keeping with the RtD ethos and to open this space of possibilities, I drew from techniques of imagination (Koskinen et al., 2011, p. 126) and speculative design (A. Dunne & Raby, 2013; Wong & Khovanskaya, 2018) for the studies reported upon in the publications II and IV. In the former publication, a 'what-if' scenario (A. Dunne & Raby, 2013, p. 86) guided our design: what if touching between strangers were not taboo but a desirable interaction? In the latter, a corresponding speculative co-design workshop (Lucero et al., 2012) revealed aspirations and values stemming from the participants' imaginations in relation to the technological futures of their boiler-suit practice.

Finally, the co-creative design approach is 'constructive' in developing and studying prototypes (Sanders & Stappers, 2014). In the field, these prototypes function as design interventions, bringing new possibilities through design proposals, in the same way 'experience prototypes' do (Buchenau & Suri, 2000) but with special focus on situations, empathy, and open-endedness – values central to ethnographic enquiry (Halse & Boffi, 2016). Such prototypes do not require final products; 'medium fidelity' suffices to provide particular core functionality *in situ* (Mäkelä et al., 2000). However, the prototypes deployed under a participatory approach must, in their social context, function to make a difference to people (Bødker & Kyng, 2018).

3.1.5 Embodied Situated Methods

One aspect of studying clothing and wearable computing is its immediacy to the human body. The dissertation project directed the knowledge toward fuller understanding of people's values, attitudes, and identities. As practices are sustained through a sum of individual performances, the physical body – as the nexus of performance – plays a central role in study of practices. Hence, bodily performance requires considerable attention. To conceptualise the design of interactive systems fruitfully, we are well advised to view 'interaction' from an embodied perspective (Dourish, 2004b; Entwistle, 2015). If we wish to elicit reactions and study changes to practices, we need physical artefacts. In an adornment context, this requires the act of 'wearing' (Juhlin, 2015; Mackey et al., 2017; Tomico et al., 2017). Besides eliciting responses, physical and digital artefacts worn on the body create ownership over one's expression. Therefore, in the project's research, the team provided materials that participants could manipulate and apply to their clothes (for publications I and IV), and our field deployment for the final study entailed probing for novel practices via working wearable prototypes.

3.1.6 The First-Person Approach

Figure 3.3. Me wearing an early prototype to enable connection to it from an embodied perspective.

For such an intimate activity as expressing oneself with technology borne bodily, it was important to juxtapose any learning from studies of participants with the designers' reflexive experience. Once I had begun the ethnographic fieldwork, it was of paramount importance to engage in the boiler-suit practice myself, by buying a suit plus adornments and wearing these to elicit reflections in others (discussed in Publication IV). In addition, I was keenly aware that any prototyping would require extensive iterative testing and adaptation with the prototypes worn on our bodies (see publications II and V).

The design process for Publication II's study revolved around the personal interests of the design group. Hence, a reflexive approach (per Bourdieu, 1990; Xue & Desmet, 2019) to designing and experiencing the artefact was crucial for understanding the sensitive topic of social touch. As we wore the prototype artefacts throughout the design process, they entered our social interactions. We wore the device in public settings to assess reactions and solicit further reflection.

3.2 Collection and Analysis of the Data

As the discussion above has highlighted, my RtD-based approach employed primarily situated qualitative methods. The foundations lay in a concerted effort to amass a solid dataset for research through observations and interviews. For an interpretative stance informed by design ethnography and reflective design research, data triangulation helped me make sense of the data. While the interviews constituted the core of the material, they were supported well by observations, questionnaires, and even quantitative instruments for assessing interactions.

3.2.1 Semi-Structured Interviews and Elicitation Diaries

To capture the participants' experiences and perspectives, the research team conducted semi-structured interviews for publications I and V and with some key informants for Publication IV. Because the field deployments necessitated monitoring participants' day-to-day activities so as to understand their practices with the digital artefact (as presented in Publication V), we utilised elicitation diaries (Jonathan Lazar et al., 2017, Subsec. 6.4.2). They aided in investigating usage that we could not observe directly and, even more importantly, helped us develop targeted questions for the semi-structured interviews. Interviewee-specific adaptation of the questions afforded personal reflections on individual-level practices. Both the empirical and the exploratory work required thus supporting openness as to the sort of knowledge to generate while also building upon a solid understanding from literature on self-presentation, fashion studies, and social computing. For the balance required, we subjected all interview data to thematic analysis. The broad-based dataset from experiences (inclusive of the participant sketches addressed in Publication I) was analysed via affinity diagrams (Lucero, 2015), and examination of the interview data behind Publication V utilised reflexive thematic analysis (Braun & Clarke, 2020).

3.2.2 Observations

Throughout the research, the cases' and studies' specifics demanded returning to both non-participant and participant observation for methods of collecting data (Flick, 2009, pp. 221–238), sometimes iteratively. For Publication I, we randomised the sampling of participants on the basis of location. Non-participant observations of the general locality served the aims of data triangulation with the *ad hoc* interview data. Similarly, in the work behind publications II, IV, and V, video recordings supplemented hand-written notes. Such recordings are helpful not only when the situation in the field precludes detailed contemporaneous note-taking;

they provide additional fuel for reflecting on observations. Importantly, we resisted any urge to rely on them as the central data source, since the RQs were oriented toward understanding people's behaviour in its larger context rather than segmenting interactions and conversations into smaller units of analysis.

In the ethnographic fieldwork focused on the boiler-suit traditions, I angled my observation as a participant toward 'going native', to aid in reflecting on personal assumptions (Gold, 1958, as in Jonathan Lazar et al., 2017, p. 238). That is, cultivating an insider view of the associated student culture and practice helped me scrutinise assumptions and connect them to aspirations on a personal level. To prevent distraction from my role as a participant, I documented pertinent observations through 'scratchpad' notes on a mobile phone. The ethnographic interviews followed a similar approach. For the field visits, I had to employ snowball sampling as the fieldwork progressed, since ethnography not only captures data but generates new data from the reflections of the ethnographer, which the endeavour must take into account (Dourish, 2014).

3.2.3 Logs, Questionnaires, and Supporting Data

Tertiary data sources supported the interview and observation data. In all participant studies, we collected details of demographic background via questionnaires that also requested information about the respondent's preferences, experiences, and routine behaviour related to the case at hand. The data helped the researchers triangulate participants' verbal accounts for Publication I. For the reporting in Publication IV, we used simple rankings to capture people's preferences with regard to speculative ideas. Finally, a questionnaire functioned as a means of preparation for the design intervention chronicled in Publication V. Additionally, we collected interaction logs for rudimentary network analysis of mediated social interactions in relation to the intervention. The resulting histogram of interactions helped us connect and interpret the individual recollections of the participants when preparing the report.

In conclusion, all of my enquiry was focused primarily on situated insight and on making use of design and technological intervention. The following chapters' presentation of the project's results benefits greatly from my use of various methods and multiple perspectives in the work. Together, these have enabled me to paint a rich picture of augmented adornment practices.

4. Everyday Augmented Adornment

(a) **(b)**

Figure 4.1. At left, the paper probe for the work presented in Publication I: a sticker filled in and worn by the participant. At right, two designers in the study behind Publication II gazing into each other's eyes, with the Hooze accessory between them.

This chapter presents two studies, which approached the domain of expressions with wearable technology from very different perspectives. One of them was a field study aimed at understanding wearable expressions in urban public settings via a broad sample of perspectives (see Figure 4.1a). The second involved a design case through which the report's authors examined expressions of social touch from their own internal perspective (see Figure 4.1b). The findings from both studies yielded insight related to the structure of augmented adornment, in response to RQ1. As both the dissertation's introduction and the previous chapter highlight, while explorations of a wide range of formats that support expression with wearable technology are plentiful, few scholars have undertaken deeper analysis of the social context (Olsson et al., 2020). Yet the roles and relationships in any given place greatly influence how people interact with each other there and how they apply technology for doing so (Farnham & Churchill, 2011; Mayer et al., 2016). The strongest predictor of sharing with collocated people is the social ties between the individuals (Wiese et al., 2011). Nevertheless, HCI work has often focused on strangers or some tightly circumscribed context (Olsson et al., 2020), without much focus on those

Figure 4.2. The six field sites in the study presented in Publication I: a bar (a), shopping centre (b), university library (c), bus terminal (d), museum (e), and 'co-working' space (f).

ties (Kytö et al., 2021). Even fewer studies in real-world social contexts remain for examination when the arena of enquiry is narrowed to augmented adornment (Colley et al., 2020; Jarusriboonchai et al., 2016; Mackey et al., 2017). While those reports that do exist offer good initial insight with regard to such adornment in public, they present a highly limited view of people's day-to-day lived social life. Undertaking larger studies, some scholars have sought to divide context into categories to inform context-aware computing (e.g., Mayer et al., 2016), yet Dourish (2004a) has pointed out that people's practices constitute the whole of context. This complicates matters considerably – defining context as everything that people do necessitates capturing everyday life beyond the office, classroom, or research lab.

For Publication I, the research team conducted a study to explore what people do in public places and confront them with opportunities to augment their adornment. We investigated personal attitudes to augmented expression, spanning various everyday localities. As the previous chapter elucidates, studying augmented appearance requires 'wearing'; therefore, we chose a paper prototype (the sticker shown in Figure 4.1a) as an adaptable form of expression that readily supports *ad hoc* interviews. To capture a wide range of participants and situations, we selected six distinct field sites, as depicted in Figure 4.2. This work enabled me to report on two key findings that shed light on the structure of augmenting adornment.

4.1 Public Everyday Expression

From among the various field sites explored for Publication I (PI), the settings with more unstructured, heterogeneous interaction, such as the bus terminal and the shopping-centre space, witnessed the most prominent reservations about wearing the sticker. Participants described the sticker as standing out for symbolising an opening for social interaction, a 'ticket' (Sacks & Jefferson, 1995) that allows two people to initiate conversation. One participant in the study stated that wearers 'lose the option not to talk to someone' (PI, p. 169). Considering public settings, Goffman described the phenomenon of exercising that option as 'civil inattention'.

Civil inattention does not explain the choice made by those participants who nevertheless used the stickers. For example, one person visiting the shopping centre over a lunch break associated the sticker with a way to express aspects of her work life: 'Obviously, I'm in the work mood at the moment, so what comes to mind is work-related' (PV, Sec 4.1). At the university library, on the other hand, most people were not so keen on wearing such a sticker, since they were focusing on their studies. That said, one student was 'killing time' while waiting for a friend and, therefore, thought about everyone else possibly sharing any current plans for activities such that he could take part in social happenings.

Our observations exemplify how people's activities might provide the main explanation or motivation for augmented adornment. Of course, audiences matter for self-presentation, and places indirectly dictate the type of audience; however, places still might encompass a wide range of activities. This factor draws attention to a structurally oriented description of augmented adornment that is based on people's activities.

4.2 Identity Giving Structure to Expressive Practices

Although participants at a given field site tended to display certain patterns, individual-level differences rather than such similarities ultimately shaped what they apparently wanted to express. We found that associations with any particular place varied from person to person and were based on individual-specific activities. In many cases, the aesthetics and symbolic meaning of wearing a sticker actually hindered self-expression.

One noteworthy finding was that some people could not reconcile the wearing of the sticker with their self-perception. They did not see a point in expressing themselves this way – they found no 'need [for] a sticker' to prompt talking to someone; however, others connected the notion of 'being an introvert' to the stickers as a resource for planning of social interactions: 'It's a little bit difficult to socialise. [... I try to] break these limits for myself' (see PI, p. 196).

Figure 4.3. Three sketches all demonstrating the participants adapting the sticker to their style, with the first panel using the person's favourite colour, the second depicting a photograph with emotional connotations, and the final one applying the wearer's preferred patterns.

Alongside assumptions related to extraversion, the sticker highlighted a conflict with some participants' styles and roles. For example, one person dropping a book off at the library on their way back from work sketched content that evoked strong feelings in her, yet the aesthetics of the sticker did not align with her wish to 'be taken seriously as a young female scholar' (p. 196). Even those people willing to wear a sticker adjusted its design to suit their style employing their favourite colour or aesthetics, as Figure 4.3 illustrates.

Considering how roles change between social situations, we examined ways in which the activities and the individuals' self-identification shaped expression practice. Sharing something personal in public becomes part of one's appearance, but people could choose the information. Hence, it did not figure decisively in a decision against wearing the sticker. This points to the importance of symbolic rather than overt meanings. One symbolic meaning might reside in what Goffman (1966) called the 'temporary ritual state', which communicates the person's situation and one or more role in the given place.

In another pattern revealed by our study, many symbolic meanings were related to people's group belonging. This is consistent with understanding wearable technology as a form of fashion. Since fashion can be considered 'self-expression as a member of a desired social group' (Tamminen & Holmgren, 2016, p. 162), in line with the reasoning laid out in the previous chapter, any technology that becomes part of adornment must address social groups beyond the current audience.

4.3 Augmented Expression for Social Touch

Figure 4.4. Two designers playfully engage with Hooze in enactment of 'hunter and prey'.

The second study in the doctoral research project attests to how identities condition the structure of augmented adornment. The autobiographical co-design study reported upon in Publication II explored how a wearable could augment expressions so as to elicit social touch. Prior work had explored the effects of using technology to support touch between strangers and probed reactions to this shared experience (Hobye & Löwgren, 2011). With our generative design, we encouraged the practice of social touch in public life through an interactive fashion accessory called Hooze. The artefact manifests zoomorphic characteristics through its furry material and subtle movements that intensify when Hooze is touched. This renders it alluring to the touch and indirectly the wearer's body. We designed the piece in a one-week workshop and wore it there and also in later public field exploration. Both reflecting on the group design process and wearing Hooze brought identity to the forefront of our thoughts.

The first noteworthy reflection to emerge, pinpointed by two cisgender heterosexual male designers in our group of three, was that wearing the shoulder piece led us to question social norms by enacting the roles of 'overly loving partners' (see Figure 4.1b) or animalistic predator and prey (see Figure 4.4. While those behaviours surely were influenced by the artefact's extravagant zoomorphic qualities, our exploration of questioning various norms associated with social touch was naturally grounded in personal curiosity. The playfulness of the setting and our work to design enticement for eliciting physical touch allowed us to express our tendencies as unique individuals freely.

The varied performances with Hooze stemmed from our evolving interpersonal relationships. We had started the design work as strangers, and we became friends through it and as we adorned ourselves with the various Hooze prototypes. Of course, the context of the design workshop opened a space for relatively free exploration. Nevertheless, throughout the process,

we performed identity work that structured the augmented adornment. Wearing Hooze concretised symbolic meanings of questioning social norms pertaining to touch and to roles within such a group as ours, workshops of this nature, and aspects of ourselves as individuals. Thus, the experience forged a connection between the activity of co-designing a wearable and the various meanings of identity.

From the results detailed in publications I and II, we can, in response to RQ1, deduce the following structure for augmented adornment practices: social identity linked to activity explains augmented adornment practice better than do utilitarian technical functions and/or classifications of context (e.g., categorisation by location). While prior work has typically approached wearables and their context as personal, relational, and locational, viewing adornment as a social practice collapses the physical place, the artefacts, and people's existing clothes into material arrangements. These materials form not a surrounding context but a substantial element of a practice.

In accordance with the model of Shove et al. (2012), the links among materials, meanings, and skills sustain a practice. Both case studies presented in this chapter demonstrate how augmented adornment, as a fashion practice, persists mainly through specific symbolic meanings connected to one's social identity. On their basis, we can conclude that understanding specific practices of augmented adornment requires solid awareness of the identities incorporated and of the existing skills that contribute to playing the relevant role. Addressing this constellation of factors, the next chapter presents the distinct practice of boiler-suit adornment among Finnish university students. The third case aided in further discriminating the elements that structure augmented adornment, and the study thereby proved central to answering RQ2 by revealing the dynamics of digital technologies' part in the performance of adornment practices.

5. Augmenting the Practice of Adorning Boiler Suits

Figure 5.1. At six o'clock sharp on the 30th of April, students have traditionally initiated the *Vappu* celebrations in Helsinki by crowning the statue–fountain structure *Havis Amanda* with an oversized student cap (photo © Atte Mäkinen).

Adornment as practice is a synthesis of various lower-level practices: buying clothes in response to needs and aspirations both, choosing one's outfit for the day, and wearing clothes that help express one's personality. While the previous chapter looked outward from augmented adornment, situating it in the broader context of everyday life, this one 'zooms in' on its details, to reveal the various elements of augmented adornment as a practice and its dynamics.

Thus, the chapter contributes to scholarly understanding. As noted above, practice-theory methodology (Kuutti & Bannon, 2014) and HCI literature on collocated interaction (Olsson et al., 2020) point to the potential value of investigating distinct cultural contexts and social settings. Indeed, design

research examining digital expression in clothing has found that clothing-practice changes triggered by digital technologies become visible to scholars who follow individuals along with their existing practices (Mackey et al., 2017; Møller, 2018). However, the few studies to address distinct settings – a live-action role-playing community (Dagan, Márquez Segura, Altarriba Bertran, Flores, & Isbister, 2019; Márquez Segura et al., 2018), artistic performances (see Dagan, Márquez Segura, Altarriba Bertran, Flores, Mitchell, & Isbister, 2019, for an overview), sports environments (e.g., Mauriello et al., 2014), and office-based workplaces (e.g., Dagan et al., 2018) – often focus on the devices' interactions instead of devoting deeper analysis to the practices involved.

To address this gap, I present the case of Finnish university students with their practice of adorning boiler suits. While it may seem peculiar, this practice stands in parallel with such strands of Western student cultures as the varsity jacket worn by 'lettermen' in the US and various formal attire in European fraternity traditions. The Nordic region's boiler-suit practice is a rich and widespread constellation in its own right, visible in most university towns and with elements spilling over into everyday life.

Firstly, through findings developed mainly in the course of preparing Publication IV, this chapter sheds light on that adornment practice and how elements of digital-technology-related practices already interlink with it. Then, I report on the speculative concepts that the students envisioned as arising with impending technological advancements. The final section delves into the changes we observed in the students' practices when introducing a prototype expressive wearable to a group of students in the work behind Publication V.

5.1 The Practice of Adorning Student Boiler Suits

From prior ethnographic research, we know that wearable devices have become part of workaday life. In the public sphere, these devices even fulfil recognised social functions. For example, headphones have been used for 'cocooning' – i.e., shielding against workplace sensory overload or cities' ubiquitous social interaction (Ito et al., 2009).

With their anthropological re-evaluation of wearables, Tamminen and Holmgren (Tamminen & Holmgren, 2016) conceptualised wearable computing as an extension of all earlier clothing technology. In light of the human aspirations revealed from that perspective, they proposed three design spaces – namely, wearables 'as technologies of discipline and control', for 'mediating love, imagination and belonging', and 'as autobiographical objects'. With the first space, designers exploit computational means to extend control over human life in certain respects. Most commercial products in the 'wearables' category today (e.g., fitness-trackers and smartwatches)

(a) **(b)**

Figure 5.2. A display capturing the earliest known instance of the traditional Teekkari student cap with black tassel (a). The back of a modern boiler suit bedecked with adornments from several years of active participation in Nordic student culture (b).

lie squarely in this category, as do typical technological studies of health, well-being, and behaviour change. Most wearable technologies deployed for collocated social interactions fall into this space: behind them is the goal of better control over people's social interactions, through such means as improving social encounters or nudging toward social interaction. Adornment spans the other two spaces quite differently, through the encapsulated processes of relating to the identity facing others and ourselves. Although start-up companies often are eager to explore spaces of wearable technology, not many have attended to these. Likewise, ethnographic studies have only in recent years begun looking at practices that cohere around self-expression and belonging (Mackey et al., 2017). In this tradition, exploring the themes linked to the boiler-suit practice of Finnish students adds a distinct case of adornment with specific cultural underpinnings. Hence, I set out to immerse myself in the Finnish students' practices for exploring the rich case of adorning their boiler suits (concretised in Figure 5.2b).

The fourth article (IV) reports on the ethnographic fieldwork that ensued. The synthesis of findings below goes beyond summarising that publication, however, since my fieldwork continued into the pandemic years and even partly into the co-creative design reported upon later in Publication V. In all, I spent more than two years in various forms of engagement with the students: observation as I participated in events, interviews in the informants' chosen environments, and reflection on my own experiences as a doctoral student (see Figure 3.1 for the timeline). At the heart of my enquiry was this question: 'How do Finnish university students perform their cultural dress practice of adorning boiler suits?' My discussion here paints a rich picture of the set of elements that structure that practice.

(a) **(b)**

Figure 5.3. At left, the collection of patches that a student carried to a communal sewing event; at right, a student with an LED strip worn around his belt.

Wearing boiler suits ties in with several other traditional practices contributing to Nordic student culture. Upon completing their secondary education, students receive a white summer cap. More than a century ago, technical students, referred to colloquially in Finnish as 'Teekkari', created their own distinct cap design, with seven corners and a tassel (see Figure 5.2a). Since the caps traditionally are worn from the first of May onward, the prelude provided by the *Vappu* celebrations held on the eve of May Day is pivotal to these students' traditions. In parallel, for just as long as they have maintained the cap tradition, the students have staged parties with a formal dress code[1] throughout the year. The practice of wearing boiler suits in connection with student activities is an outgrowth from engineering students' donning these to handle materials and machinery in workshops. Over the last 30 years, the practices underwent a further dramatic shift, albeit a slow one: decorating these with cloth patches and otherwise customising them has grown commonplace.

Today's form of the student practice covers a wide spectrum of **materials**, the first component. Its basis is still the summer cap, particularly the now legally protected design complete with tassel (see Figure 5.2a). Once this sign of affiliation has been earned, it functions as a relatively general status symbol, whereas the boiler suits, with their dedicated colour for each degree programme, function as more specific identifiers of group belonging and individuality. In their role as a canvas, they function in the ongoing practice of adorning with ever-new symbolism. Drinking cups, customisation such as added hoods, and other creative attachments are applied to adorn the boiler suit. The most typical materials for doing so are cloth patches, whether collectables (see Figure 5.3a) or more banal-style ornaments (see

[1] Traditionally white-tie, as described on the Wikipedia page https://en.wikipedia.org/w/index.php?title=White_tie&oldid=1092822565 as of 2022.

Figure 5.2b). The patches function to assert a commodity's identity in the reproduction and consumption of meanings, and they completely cover the suits of the most active students. However great their variety and lavishness, all adornments of the suits are meant to be robust, in that the student activities typically involve drinking and outdoor use.

In their more general function as outerwear, these garments are worn beyond organised events too. As the students, adorned in their suits, leave the confines of the university infrastructure for gatherings at pubs, to converge in public outdoor spaces, and even to roam the streets on trips abroad, one underlying structure remains: the student union. The framework features various clubs, subject-based associations, and smaller 'teams'. Formal infrastructure dependent on these organisations permeates all facets of a student's life, from club rooms to student housing.

Digital materials and electronics are already part of the self-expression in 'boiler-suit culture'. The patches often depict popular media entities and exist as analogue transpositions of the Internet memes that circulate in numerous instant-messaging chat groups, as exemplified by the Teekkari adaptation of Super Mario and the Finnish Donald Duck meme picture in Figure 5.3b. The belt of light-emitting diodes in the latter pane attests to how some students already integrate wearable electronics into their outfits. One student interviewed in the research had even built an interactive wearable device in the form of motion-reactive cuff lights.

The **competencies** that sustain these adornment practices revolve around the skills of meshing with a particular student culture while simultaneously standing out as an individual. The oldest extant samples of student boiler suits, dating from the 1960s, already were given lettering on the back to signify group membership. Accordingly, one could argue that these overalls function not as fashion in the classic sense but as a uniform. That said, extensive customisation with patches and electronics is a central competence in practising boiler-suit adornment. While the electronics implementations stem from engineering skills, the general practice as an entity bears elements of creativity and craftsmanship both. Semi-formalised rules dictate that the patches be sewn onto the overalls by hand. If they are to engage in the adornment practice, students need to be able to utilise their skills to make something unique. Producing plausible expressions of self is just as crucial as performing group belonging.

Finally, the **meanings** that the boiler-suit adornment practice comprises are bound up with the students' social identities. Identifying as a 'techie', as skilled in crafts, and as well-versed in local memes are components of identity inherent to the students' adornment practice. Consequently, large parts of the cultural practice revolve around belonging to an in-group: the Teekkari cap, the profession- or guild-specific colour of the overalls, and first-year teams' emblems all signify affiliation.

Alongside these more formal structures, 'rowdiness' is always present

as a theme for this student culture. The students express this theme and perform its meaning by testing and challenging social norms. While they exhibit a shared understanding that acting out this central theme – for instance, through overtly excessive drinking and partying that question the norms of 'normal' social life – is appropriate, their individual-level performances do demonstrate divergence. Students differentiate themselves by acts of defining norms and personal boundaries. One informant exercised such norm differentiation by deciding not to use a patch that 'riffs on' the Holocaust. The bricolage of patches and other adornments is intended to render each student's boiler suit unique and memorable, an expression of individuality. A particularly striking personal statement of common practice is the exchange of sleeves between romantic/life partners to express the mutual relationship.

While their expressions of individuality reference specific existing symbols, the students wield their traditions in a manner that is noteworthy for its innovation. Instead of taking these traditions as immutable, the students actively strive to establish new ones. This was articulated, for example, in a key informant's process of establishing the bioengineering guild's annual participation in a sweets-eating rally in a remote municipality. The numerous meanings of expressing individuality unequivocally link the boiler-suit practice to identity development. Being a young student finding one's place in the world is fundamental to the persistence of the adornment practice, which naturally ends no later than graduation for those taking part.

In Publication IV, I showed that the students' adornment practice revolves around development of identity not just for those becoming part of some symbolic group but also in their shaping of that group's identity itself via individuality. As various other fashion practices do, wearing these boiler suits pursues the aim of standing out while fitting in. In fact, the boiler-suit culture resembles live-action role-playing and cosplay in its acceptance of idiosyncratic digital augmentations. Electronics and digital technology already permeate all elements of this practice: the materials, spaces, meanings, and even skills. At the same time, this adornment practice is not merely an occasional dress but structures the students' everyday life.

5.2 Opportunities for Design of Augmented Boiler Suits

Because my core aim was to understand augmented adornment with wearables from a situated perspective, I examined the nature and specifics of the practice of boiler-suit adornment, described above. However, my research was directed also to identifying the dynamics of adornment practices and, thereby, pinpointing design guidance that could inspire adoption.

This is why I could not reasonably limit the ethnographic study to concrete design implications: ethnography informs through thick description. To answer my questions, I followed design and HCI scholars' recommendation of employing speculative design for transferring in-depth knowledge, since the cultural context enhances design and supports openness to interpretation (Khovanskaya et al., 2017).

To this end, we used the co-design method known as *dialogue labs* (Lucero et al., 2012) to speculate with the students about the future of their cultural practice based on state-of-the-art wearable technologies that are expressive and interconnected. We asked: 'How will future Finnish university students use social wearables to enhance their outfits?' The potential that the students, as experts in their own practices, saw in the technology should aid in mapping futures of augmented adornment. With the subsections below, I discuss the key concepts that emerged derived from the ideas and preferences the students expressed.

5.2.1 Dynamically Display Belonging

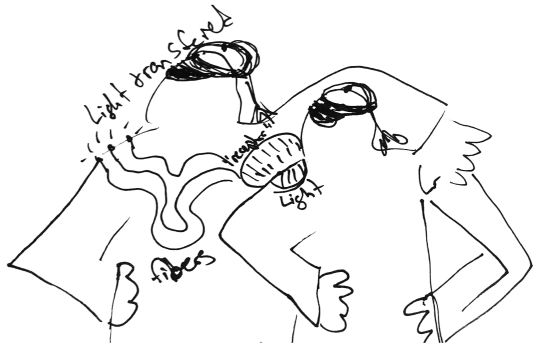


Figure 5.4. A sketch for the idea of overalls lighting up in a specific colour when two people embrace each other.

As the fieldwork elucidated, the practice of boiler-suit adornment revolves around developing one's identity by negotiating standing out while fitting in. The ideas valued most by the students express this theme. One design concept repeatedly surfacing in the students' ideas was that of **personal displays as conversation-starters**. This theme, which is commonplace more generally, has received extensive attention in the HCI field. However, an even more prominent concept emerged also: **displaying groups dynamically**. The most popular idea in this category is sketched out in Figure 5.4: by embracing one another, students can cause their overalls to light up in a distinct colour, thus expressing community. Even those ideas similar to personally collecting and trading patches were favoured primarily for their support of belonging, as opposed to their individualistic

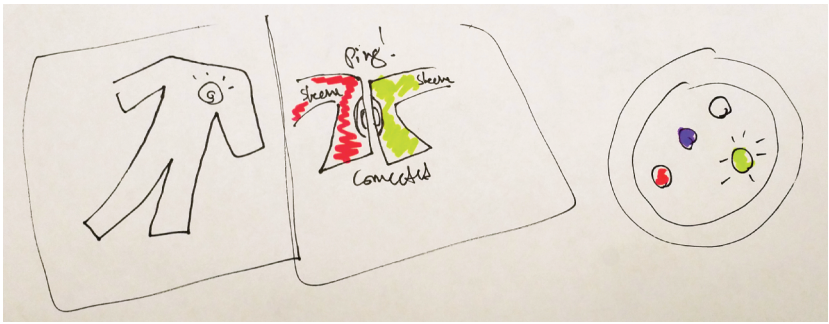


Figure 5.5. A sketch depicting a badge that adds the corresponding colour each time the wearer bumps arms with someone from another guild, university, or city.

aspects. One idea receiving high marks from participants is a system that tracks connections between students and rewards those 'collections' of acquaintances that show the greatest variety (the idea of collecting such digital badges is depicted in Figure 5.5).

5.2.2 Standing Out Through Versatility

Figure 5.6. A textile prototype of a tail attachment that sprays confetti when pulled.

Again, complementary to the practice of displaying belonging is that of showing oneself to be distinct. The above-mentioned ideas cohering around the notion of **digital badges as collectables** dovetail with practices of crafting something unique also. Adding emblems for events one has attended, people one has met, etc. highlights the overalls' function as a graphical display of each student's biography.

Many students' ideas were oriented toward displaying social status and manifested an urge to express individuality. Therefore, **drawing attention** was another design concept they appreciated. Figure 5.6 presents the

Figure 5.7. 'Infiltrator overalls' afforded by suit templates: camouflage using the colour of another guild to sneak into its private events.

example of an interactive tail. When others tug on it, a spray of digital confetti follows.

The concept of **concealing identity via camouflage** was the most striking manifestation in the individuality-expression category, in that it involves changing one's identity, at least figuratively. With the overalls design sketched in Figure 5.7, a student cloaked in the identity of another guild could crash its parties and play pranks. While students' ideas in this arena were connected mainly to playfulness and benign mischief, they did raise concerns about boundaries. For example, copying the colour of another guild could dilute the meaning of the dedicated colours. Likewise, some ways of attracting attention raised concerns about invasiveness, e.g. how speakers will create undesirable noise for others.

Thus, the constant balancing between expressing individuality and staying within the delineated bounds of social groups unfolds. The speculative co-design described in Publication IV revealed broader implications of digitally extending the practice of adorning boiler suits. Participants in the study accorded the greatest value to concepts that represent extensions from the existing practices rather than merely an additional technical function. However, there is a double-edged sword in the design concepts' and spaces' entanglement in a complex web with existing practices of adornment, as the students' worries about undesired attention or problematic identity play attest. For good or ill, the ideas demonstrate how wearable technology could integrate but also reinforce the social functions of dress by offering new materiality to their practice.

5.3 Augmenting Adornment with an Interactive Cloth Patch

Figure 5.8. The co-creation kit distributed to students.

While we have described possible pathways toward wearable technology that merges with existing adornment practices, a fundamental question remains: which elements of the practice change, and what dynamics does the change bring? To collect more evidence of *how* expressive wearables might alter social practices of dress, I studied in situ reactions to a physical prototype embedded in existing practices, to examine the dynamics as they emerge: the research team conducted a design intervention with an interactive wearable integrated into students' dress. Publication V describes the intervention's development process and our observation of the augmented-adornment practices that emerged. After an extensive co-design process (building on the findings reported upon in Publication IV), we delivered 20 interactive cloth patches in the form of a co-creation kit (shown in Figure 5.8). Once the students had crafted personalised patches, we observed their actions closely over two weeks through an elicitation-diary-based study that encompassed several organised events.

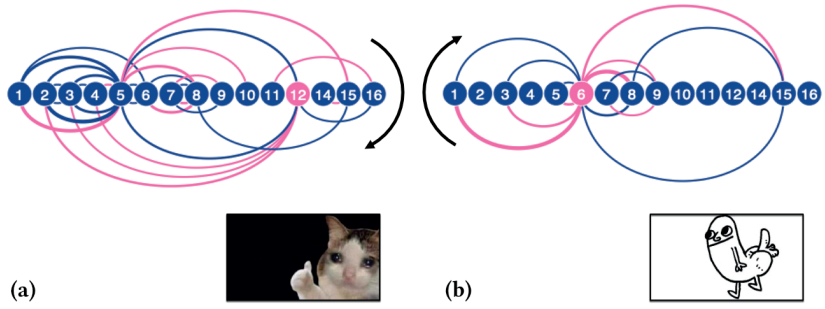
The design in Figure 5.9a, draws together concepts that the students devised in the work behind Publication IV (see Section 5.2). Proximity-triggered coloured lights signify group membership, blinking out specific animations to a set user-defined tempo. Additionally, small digital images displayed by the patch can be collected and traded via a patch-to-patch electronic interface.

Digital Content Augmenting Finnish Students' Current Dress Practices
Consistently with prior outputs (e.g. Chen & Abouzied, 2016) and with the design concept of dynamically displaying belongingness, the Digi Merkki patch functioned as a 'social lubricant'. Just as the analogue patches on

(a) (b)

Figure 5.9. A Digi Merkki below a normal cloth patch on a participant's suit (a) and students posing with their Digi Merkki, with their suits worn open-style (b).

suits invite others to engage in conversation about the wearer's biography, the design of the e-patch and the contents of the user-chosen images functioned as *tickets to talk* (as in Sacks & Jefferson, 1995). Digi Merkki's nature as a biographical resource manifested itself as students reminisced about their experiences with it while sifting through their collections of digital images. However, Digi Merkki not only emulated the existing practice; its materiality gave it a new intensity, through the range of digital imagery available, the lights' ability to draw attention and facilitate expression, and connectedness whereby students opened another channel for interpersonal interactions. This supports the supposition in Publication IV that augmented adornment can amplify the social functions of clothing.



(a) (b)

Figure 5.10. Network graphs that plot two pictures' dissemination among participants, where each clockwise curve represents the image's propagation to a another individual participant. Magenta lines trace initial propagation starting from the magenta-coloured node. The thumbnail images below the graphs show the corresponding images (for pane b, ©KC Green).

Digi Merkki Fostering Change to Social Practices

These new resources gave rise to proto-practices. Three students introduced dare-based challenges as prerequisites for picture-trading: accompanying each picture were conditions that had to be met before sharing could occur. Interestingly, this additional procedure integrated into the trading process spread from one student to the next, thus rapidly gaining a foothold as a distinct practice within the group of participants.

When students discovered a way to exchange pictures with an unsuspecting partner, the proto-practice of spamming in picture-trading emerged. The students tested various types of interception/interference, hijacking, and spamming, with their tradition of 'rowdiness' providing sufficient know-how and meanings as a backdrop for these actions. Finally, there was a playful element, too. The meaning of teasing someone via this proto-practice was bundled with existing digital material, the tool of the 'thumbs-up' cat (see thumbnail in Figure 5.10a). Thus, Digi Merkki enabled new links between materials, meanings, and skills in multiple ways.

Students Navigating Emergent Practices for Their Gain

Those new practices were not without tension, however. For instance, aversion shown to the Dick Butt picture, as in Figure 5.10b), motivated one student to propagate it through the spamming exploit all the more. Despite such tensions, the students actively discussed inclusion and norms related to the technology, and they attempted to manage their community correspondingly. While, as expected, we found multitudinous individual-to-individual differences in how they carried out their adornment practice with the aid of digital tools, the community-level negotiation evident in those individuals' collective action clarified how the practice as an entity may be actively shaped. These findings are consistent with the observations at the heart of Publication IV, with regard to the adornment practice cohering around identity development with a focus on new meanings and traditions.

From multiple angles, we observed how the students structured their meaning-making process utilising *memes in digital culture* (Shifman, 2014). Whether instantiated in mimetic content or dare-based challenges introduced by participants, *memeing* was prominent in the students' actions. Likewise, the project revealed how our intervention's characteristics support involvement on precisely such terms. The students could create meanings by interpreting media content, interpreting others' actions, and cultivating value through new proto-practices. The digital materiality that Digi Merkki added to the boiler suits linked preexisting adornment practices with a new digital practice. Although choosing mimetic pictures more obviously invited assigning new meanings, the dares that students introduced follow the pattern of memeing. The latter practice, already present in this community to some extent, became fully integrated into

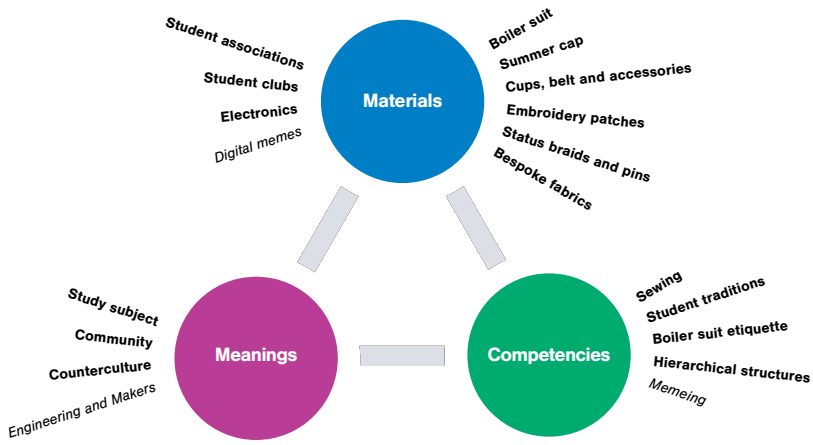


Figure 5.11. The elements of the boiler-suit adornment practice, with their digital influence highlighted in purple italic text.

the students' clothing and social-interaction practices by incorporating the intervention, as demonstrated in Figure 5.11.

Adressing RQ1: Which elements structure augmented adornment practices?

With the findings from the specifics of this case, we can paint a thorough picture that fleshes out the skeleton of the structure of augmented adornment, which I was able to outline in the previous chapter based on the earlier studies. While already aware that technological augmentations of adornment revolve around personal and group identities in the context of a given activity, the further work spotlighted how the activities particular to the Finnish students coalesce around belongingness and building a visual biography inscribed in the boiler suit. Thereby, we can map embedding of wearable technology to two vibrantly evolving design spaces identified by Tamminen and Holmgren (2016): those of mediating love and autobiographical wearables.

Another newly highlighted aspect of the picture informs scholarship profoundly. Prior studies, focused primarily on material aspects of integrating technology, identified a prevailing distaste for overly 'digital' aesthetics (Devendorf et al., 2016). In contrast, my findings draw attention to the nuanced conditioning of meanings: the crucial element is the cultural practice at hand. The student community in the case study welcomed 'techno-aesthetics', thanks to such factors as those aesthetics' existing anchors in the boiler-suit practice. While some participants highlighted the importance of a soft fabric appeal, several even designed hard external cases to guarantee the functionality and endurance of the Digi Merkki device.

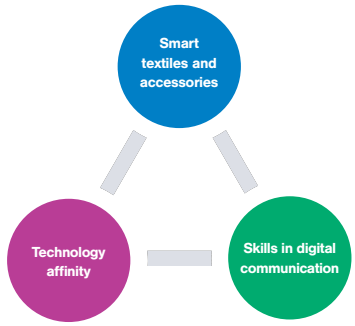


Figure 5.12. A diagrammatic visualisation connecting the core elements articulated for augmented adornment.

I conclude that the meanings called upon in an augmented form of adornment need to mesh with the performers' identities. This requirement transcends explicit markers of style or symbols of group membership. Far beyond such imagery, adorning with interactive technologies is a highly symbolic performance and must be consistent with the individual's social identity. While practices of wearing technology are utilitarian in that sense, the alignment need not entail emphasis on any particular aesthetics, as the Teekkari approach to wearability attests. But practising adornment augmented by digital technologies does prove unsustainable when it cannot 'plug in to' some meanings of the performer's social identity.

Secondly, links to existing elements of the adorning practice emerged as a vital notion. The students valued the changes they themselves made to the suits, outfits that express identities centred on their fields of study. With the intervention, their 'analogue' process of sewing on patches and otherwise adjusting the suits became interlinked with various digital-domain competencies that these (predominantly design and engineering) students acquire through their study interests. Their affinity for technology-based innovation brought this adornment practice into connection with digital technologies from the outset, as was evident from the bespoke electronics that some participants created. While this connection is specific to techno-affinity-related meanings, it highlights the skills demanded for performing augmented adornment more generally. A prime example is visible in the students' reliance on their memeing competencies, which illustrates nicely that people refer to their existing skills when employing digital technologies to augment their adornment. Therefore, I recommend understanding augmented adornment's structure as smart textile materiality linked to meanings of technologically affine identities and skills. Accordingly, I propose the model depicted in Figure 5.12.

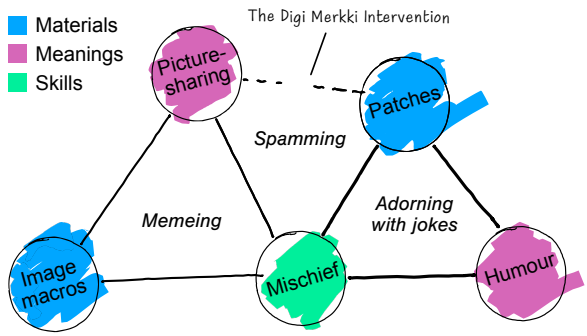


Figure 5.13. The proto-practice of spamming – with its connection to the boiler-suit practice and memeing – manifesting digital technologies' ability to link digital-domain practices and adornment.

Addressing RQ2: How do digital technologies contribute to the transformation of adornment practices?

Using these examples of linkage between adornment and digital practice, we can proceed to address the second research question for this dissertation. The design intervention's deployment illustrated how bringing digital materiality into this particular adornment practice led to proto-practices based on participants' digital practices. Thus, I showed a linkage on all three crucial components: materials old and new, meanings from digital media, and the students' competencies in for example memeing. Adoption patterns exhibited connections with applications in online memes (in the case of the dares) and a relationship with online practices such as trolling (evident in the phenomenon of spamming). The student community gradually adjusted the emerging proto-practices in both cases, with meaning-making then getting woven back into the social function of self-identification through adornment. Figure 5.13 outlines this process regarding spamming. Thus, augmented adornment might lead to the amplification of certain fashion-oriented practices connected with distinctness and/or belonging to a group. In turn, the adoption processes' effects – positive and negative – may get amplified. Hence, they hold potential to encourage problematic couplings such as the sense of belongingness *cum* polarisation that has proved so problematic in online media generally.

While the students' successful adoption of novel practices provides evidence that technology can support adornment, this relies on all three components of adornment. Likewise, when assessing the technologies influence, we can conclude that they extend to all elements of adornment. The meanings are construed against the backdrop of socially anchored perceptions of digital technologies (in the boiler-suit case, via engineering and design as foci of personal identity). In tandem with propagation of new communication technology, people bring their digital-communication

competence into adornment. Finally, the digital materiality and the materiality of garments intertwine, as the evocative wearing of meme-based pictures illustrates well.

6. Design for Practices of Augmented Adornment

As I highlight in a thread running throughout this dissertation, technology for adornment represents a sensitive design space; ultimately, people maintain and develop identity through expression practices that are highly personal and complex. Following on from the preceding two chapters' discussion of the structure and dynamics of augmented adornment, this one tackles the final research question, centred on guiding principles for design. To answer RQ3 and, thereby, support augmented-adornment design commensurate with adoption and long-term use, I developed insight related to methodology, design perspective, and a strong concept for design. Accordingly, I begin the chapter by outlining a suitable practices-oriented approach to RtD (elaborated upon in Publication III), enriched by method-related reflections based on the case studies. With the section after that, I propose a *dialogue-based perspective* intended to facilitate embedding the design of augmented adornment in the meaning-making formulated for Publication V. Finally, I present the strong concept of Memetic Expression to connect this perspective to a practical tool for designers' application to support mediation through discourse and community.

6.1 Research through Co-Design of Practices

Adopting expressive wearable technology and proactive fashion tech is a context-dependent problem. Through the doctoral project's various publications, I have argued for identifying and constructing intermediate knowledge. For instance, Publication III outlines a research approach that speaks to the vital theory- and method-connected considerations highlighted in chapters 2 and 3: studying changing practices via constructive design research. On this basis, my methodological stance involved engagement with RtD akin to experimental research (Koskinen et al., 2011). I articulated, in essence, how any research into expressive wearable technology demands obtaining a perspective on the symbolic world of people's lives by diving into their practices and conducting field interventions via

such means as participatory workshops. Below, I elaborate on the three associated steps presented in Publication III, alongside my reflections from the case of the boiler-suit culture (see publications IV and V, and the autobiographical design in Publication II. From those reflections, I have refined the three steps into a model that entails 1) gathering in-depth knowledge about the 'target practice'; then, 2) a co-creation phase; and, finally, 3) design interventions.

6.1.1 Understanding an Adornment Practice

In that the methodological underpinnings are rooted in RtD, the process follows the lines of design. When employing it, I rely primarily on the practices-oriented design pioneered by Kuijer (2017). Similar to the latter approach, my first step consists of coming to understand the practice central to the enquiry. Since dress cultures in modern societies are highly specialised and local, I recommend methods illuminating the practice-carriers' living worlds. One example is short-term ethnography (Pink & Morgan, 2013) that includes participant observation. This enables the researcher to be immersed in performers' everyday lives. A case in point, how I overcame the sense of disconnection as my experience of overall-wearing unfolded (chronicled in Publication IV) highlights the value of sensory ethnography (Pink, 2009). It might even be invaluable, for designing 'smart garments' requires an embodied understanding of wearing the clothes (Mackey et al., 2017; Tomico & Wilde, 2016).

The case of the boiler suits demonstrates the importance of enquiry into genuine practices 'on the ground'. The meanings of a particular practice may be shrouded beyond the view of outsiders. For example, framing summer caps as a century-old tradition might cast the culture in a conservative light, yet my fieldwork revealed how the boiler-suit culture's traditions are in constant flux – they are continually redefined and extended as the students express the esteem in which they hold making a mark. While practices-oriented design, as introduced by Kuijer, focuses on a detailed account of minute, atomic actions, attending to the sequence and arrangement of adornment or similar communicative practices requires more: deep understanding of meanings. Concerning wearables design, Tamminen and Holmgren (2016) suggest that such a focus enables designers to connect with the 'symbolic world' of the users and thereby overcome a technological or normative imperative.

6.1.2 Participatory Making of Digital Wearable Artefacts

To carry an understanding of the target practices into action, I suggest that participatory workshops should function well to confront prospective users with the prospect of change. After all, change constitutes the ultimate aim of any design effort. While co-creation operates as a valuable tool for generating design opportunities, it simultaneously reveals participants' aspirations and the value system often implicit in the community of practice. For example, in the work behind Publication IV, students' reactions to speculative scenarios helped unpack the values and norms attendant to their boiler-suit adornment practice. For example, some stated that dynamic colouring has limits because the suit's colour signifies one's affiliation. Besides such clear demarcation of values, participants echoed subtler meanings of the practice in their preferences across the various design concepts reported upon. This crystallised in, for instance, the design intervention's unintended support for memeing-related properties, a culmination of building on the concepts created and chosen by the students earlier (in the study presented in Publication IV).

Furthermore, material engagements activate participants' expertise through engaging in the practice (Perner-Wilson et al., 2011). These people are the experts in their own everyday doings (Bødker & Kyng, 2018), so asking them to create reveals their skills as another constitutive element of social practice. Similarly, an embodied perspective requires wearing suitably functional prototypes within relevant context. The role-playing described in Publication II revealed how Hooze might lead to undesired touch through associations with the 'predator and prey' trope. Thus, it helped us problematise how intimacy/distance gets expressed. Importantly, the process is incremental and iterative; accordingly, Publication V stresses the co-designers' need for repeatedly wearing the prototypes so as to understand the artefact's place in their social practices, not just from an experiential perspective but as a tool for reflection.

The team also found that hand-crafting assists in personalisation (Perner-Wilson et al., 2011) and connects participants with the technological artefacts produced. Co-creation forms a gateway to an emotional connection to the electronic garment. In the first-person exploration behind Publication II, our personal relationships with Hooze enabled us to share a moment and engage with the research questions from a profoundly intimate perspective.

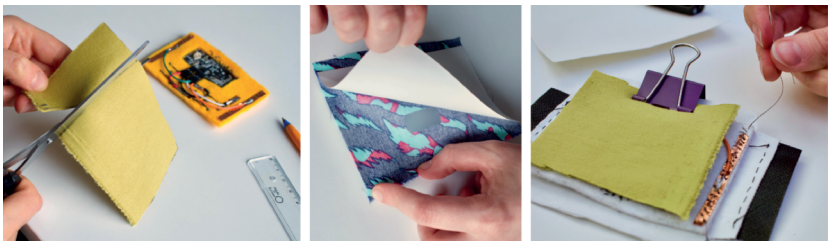


Figure 6.1. Three instructional images that guided the participants' creations.

The finished product distributed for the final field study was developed as a jumping-off point for a personal connection. This co-creation kit, with its ready-to-use electronics and instructions for producing a personal patch (see Figure 6.1), presented an option of adjusting the patch contents and aesthetics, while still allowing people to express themselves flexibly. Through this connection, Digi Merkki became a valued artefact that we found students still wearing a full year after the intervention[1].

However great the importance of embodied and material engagement, technological artefacts should never become the sole focus of the investigation – emphasis should remain on the practice as the unit of analysis. The meanings and competencies making up the practice must be carefully dissected. In the case of the boiler suits, studying historical accounts of the cultural practice and paying close attention to the individual performances in their local context assisted in understanding the practice. This illustrates the crucial role of field visits in grasping the practices under study, whether in the initial step or in parallel with the larger process.

6.1.3 Design Interventions in the Field

Because the dynamics of practices constitute the core of the enquiry, we require accounts of people's actual evolving practices with the digital artefacts. Though the HCI discipline boasts a rich tradition of research 'in the wild' (Johnson et al., 2012), most of its scholars focus on evaluating purely the technology. To offer any perspective on social practices, studies must not stop with the design or technological system itself. Bødker and Kyng (2018), keenly aware of the socio-technical balance required, concluded that prototypes must provide sophisticated functionality in the field if they are to confer knowledge of people's real-world situations. Making prototypes work well enough for this requires iterative design and testing. The prototypes' functioning and meaningfulness to participants must be sufficient for their incorporation as elements of a practice. Thus equipped, we can capture the dynamics of the practice rather than mere reactions to the ideas a prototype represents.

[1] Follow-up enquiry with three participants revealed this in June 2022, some time after printing of the publication.

(a) **(b)**

Figure 6.2. Left, I wear the Hooze accessory in public, while a stranger touches the device; right, students using the Digi Merkki devices at a gathering.

For the RtD artefact discussed in Publication II (i.e., Hooze), wearing the prototype publicly was essential. Being enticing made it into a play-linked fashionable accessory – i.e., adornment. By wearing Hooze in public spaces (see Figure 6.2a), we could reflect on the potential sparked by our design group's exploration. The artefact became a fashion accessory through the process, not by virtue of intent.

In the study detailed in Publication V, it was the intervention that prompted our discovery that memes operate as a structuring element in the students' practice. As Section 5.3 explains, the emergence of dare-based challenges and spamming revealed the importance of memes in this culture at a level beyond meme pictures (also known as image macros). This evolution of practices was not derived from the prototype in isolation; it had roots also in the intervention's groundwork-based focus on students' living worlds. The students took ownership of the proceedings employing essential decisions on everything from the study setting to the final personalised designs.

In conclusion, the three steps provisionally outlined in Publication III proved fruitful for revealing shifts in social practices and the growth of proto-practices. The guiding principles for design, to which I devote the discussion below, sprouted from insight produced via this integrated process.

6.2 A Dialogue-Based Perspective for Mediating Wearable Technology's Adoption

Proceeding from the findings of the three case studies and applying design from the perspective of practices, we proposed a design stance specific to the adoption of augmented adornment in Publication V.

This addresses a recognised gap in HCI research into wearable technology, discussed earlier in the dissertation: it often focuses rather narrowly on social acceptability. In contexts such as adoption of data-enriched glasses, acceptability proved insignificant for take-up (Koelle et al., 2017). Likewise, in cases of wearables that augment social interactions, adherence to acceptability-based models has not led to adoption. There are several aspects to this. For example, while ease of use is a major element of many established user-acceptance models (Sinha & Gupta, 2019), optimising for usability can create impediments to designing organic experiences with technology that develop over time (Fallman, 2011). Some scholars have called attention to this conundrum (Gaver et al., 2003):

> Traditional concerns for clarity and precision are superseded in [systems outside a workplace context] by the need to provide rich resources for experience that can be appropriated by users.

As people appropriate technologies in unforeseen ways (Salovaara & Tamminen, 2009), they reconfigure what is usable and acceptable anyway. Hence, my findings connected with the boiler-suit practice suggest that it might be more valuable to hone in on the meaning-making in which the people engage. Taking a similar tack, Uhde et al. (2022) proposed a focus on meanings in their criticism of prevailing design strategies for social acceptability, all of which seemingly revolve around unobtrusiveness (Koelle et al., 2020).

Especially in areas where wearables move, the meanings that make up a practice and dictate social acceptability are themselves constantly in flux. Aesthetics, social identities, and cultural norms change over time for every individual. If we consider augmented adornment in particular, we must assume that fashion-related practices are a part of forming social groups in an iterative cycle of association and dissociation (Entwistle, 2015). Consequently, scholars have urged the design of wearables (L. Dunne et al., 2014) and ubiquitous computing (Dourish & Bell, 2011) to mediate how such meanings evolve.

From their work on textile screens, Devendorf et al. (2016) called for ambiguity as a resource for design (Gaver et al., 2003), with the aim being openness to the full range of experiences. This dovetails with the observation in Publication I that participants consciously employed vagueness and ambiguity in their augmentations to fill in details and establish meaning. Furthermore, we exploited the design principle of ambiguity ourselves for Hooze, to intrigue bystanders and add to the wearable's enticement-oriented properties. That said, ambiguity is often designed to remain implicit in representations (Devendorf et al., 2016). It gets reduced to an entry point for engagement, seldom exploited explicitly for continued reconfiguration.

Looking beyond the representational layer, we must acknowledge the more complex reality of the socio-cultural forces at play, and our understanding ought to develop accordingly.Publication IV captures the students' demands for flexibility in future designs. From these individual-level articulations, the research team concluded that the participants' concepts required room for reconfiguring the functionality. In the final field study (behind Publication V), we documented how the open-endedness of the interactive cloth patch and the participatory approach to the intervention aided in precisely such reconfiguration. The participatory nature of our design process supported bottom-up social organisation. Open-ended design – in which goals and activities can be determined by the user (see the description by Boon et al., 2018) – and user-generated content helped to cater to preexisting cultural meanings and to build on the students' competencies. Also, the fact that the students assembled and customised the final device made it a more meaningful artefact. This engagement is particularly important if we regard technologies for augmented adornment as a collaborative system, in that research has revealed social influence to be the main driver for adoption (Olschewski et al., 2018). Ultimately, it was the designer–student dialogue that developed the meaning of the social wearable.

In more general terms, we can characterise this ongoing dialogue (behind a specific design or the design process) as a valuable approach to mediating the adoption of social wearables, as addressed in Publication V. Establishing it requires designers to view meanings as unstable outcomes of ongoing negotiations (Barnard, 2014, chapters 6–7), with answers to such questions as 'Is spamming others with my pictures appropriate?' being conditional. By drawing attention to contingency, a dialogue-based perspective can guide design processes for augmented adornment or other social technologies. At base, the design should mediate meaning-making such that social influence and meaning can emerge in the negotiations. Proceeding from the characteristics of augmented adornment that I identified in the dissertation project, I propose design from a dialogue-based perspective that transcends the device–user dichotomy, one that extends the openness and dialogue beyond the wearable technologies themselves. Such a perspective should aid users in bringing the technology into their everyday life. The following section offers a concrete demonstration of a concept that translates this theoretical understanding into a guiding principle suitable for practitioners.

6.3 Memetic Expression: A Strong Concept for Design

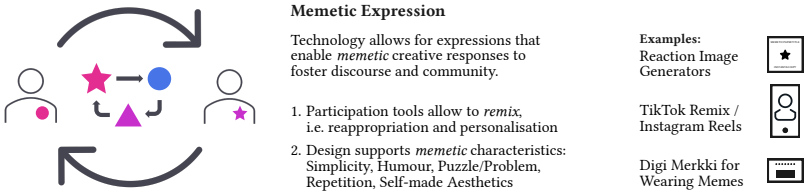


Figure 6.3. A diagrammatic overview of the concept of design for Memetic Expression, encompassing both the core principles and three examples.

The concepts of openness and dialogue may seem nebulous and hard to realise via concrete design steps. To address this issue in light of the findings detailed in Publication V, we formulated a strong concept (Höök & Löwgren, 2012). As a physical artefact and an intervention (introduced for joint activities), Digi Merkki provided students with new material for their practices of expressing themselves through their overalls. By forming an element in that practice, it grew connected to their practice of memeing as a playful way of participating and developing their community. It is on the basis of this linking of practices that we expressed the strong concept for design. The concept posited, Memetic Expression, also incorporates dialogue and openness, albeit indirectly. The mechanics of memes in digital culture have been subject to extensive study (e.g., Shifman, 2014). Online memes (built on a shared idea propagated and imitated as groups of content units) still may be readily confused with *virals*, distinct pieces of content propagating rapidly through social media. The most important element to recognise here is that memes always function in relation to communities and therefore serve to foster discourse. By attending to their patterns and mechanisms, we can exploit factors that contribute to memes' success and benefit from examples of existing infrastructure that enable or support mimetic expressions. Awareness of the characteristics of memes allows the designer to link memeing to other practices involving social technology in general and wearable-linked expression in particular.

Under our concept of Memetic Expression, the central requirement is to create participation tools for 'remixing'. The main principle is to give people the means to participate in generating and reappropriating content such that community involvement flourishes more fully. This principle builds on our theory-informed understanding of an appropriate dialogue-rooted perspective, as formulated in Section 6.2. Secondly, the design should support creating content with mimetic characteristics to heighten opportunities for use – i.e., propagation, adoption, and adaptation. The characteristics most relevant for this can be derived from the work of Shifman (2014, Ch. 6) and can be paraphrased as *simplicity*, *humour*, *a puzzle/problem*, *repetition*, and *self-made aesthetics*. To support real-world

Table 6.1. Design principles for Memetic Expression as a strong concept

Participation	Are users actively involved in shaping the sensing–actuation interplay? What tools does the design offer to afford participation? How can users/wearers express themselves freely? Is a 'remix' of meanings supported?
Simplicity	Does the digital expression allow for preexisting symbols? Does the actuation occupy the 'sweet spot' between explicit and implicit information?
Humour	Does the design leave room for unexpected uses and surprises? Does it build on playfulness?
Puzzle	How can the interaction be more effortful and, hence, more meaningful for those taking part? How does the design support gameful task-completion?
Repetition	Does the system support repetition by lowering thresholds to exchange of (mimetic) content?
Self-made	What in the design's aesthetics expresses something genuinely made by the user?

design work that employs this strong concept, I present guiding questions in Table 6.1. Publication V explicates the various characteristics' relations to interaction design in greater depth. For example, humour has been posited as a potential driver for interaction design (Iivari et al., 2020). The strong concept gains vertical grounding in relevant theory by means of connections to scholarly conceptions of Internet memes and to established principles applied for HCI.

For horizontal grounding, in turn, the empirical case of designing Digi Merkki aids in articulating the principles central to Memetic Expression, as do experiences from other applications and services. For many people, the first mental image conjured by the word 'memes' is of social-media-circulated images with prominent text at the top and bottom. The prevalence of these image macros in online communities is largely due to tools for generating variations based on preexisting templates. In a similar vein, the recent success of TikTok has been linked to its remix feature. Publication V delves into how image-macro generators and also TikTok remixing and other platforms' later versions of it (e.g., Instagram reels) always follow the above-mentioned underlying principles of Memetic Expression. For example, simplicity is achieved by designed-in limits that restrict the content's format, with constraints to video length being the most prominent example in the TikTok case. Another affordance in the example case of TikTok is the remix support it supplies: it provides for easy repetition (audio and video can be reused readily), and the service's tools make it easy to add a personal interpretation.

Addressing RQ3: Which design approaches can propel wearable technology's adoption and routinisation in adornment practices?
With this chapter, I have presented answers to my third research question on several levels. The strong concept provides a framework for concrete guidance that supports designing a wearable with solid integration into

everyday adornment practices. While tying the design efforts to memeing might confine the concept's application somewhat to communities strongly bound up with Internet culture, a broader pattern may indicate otherwise. Memes' popularity has been attributed to a broad-based profound shift toward a more participatory culture in societies' networked everyday (Shifman, 2014, Ch. 6).

This ties in with the second finding connected with RQ3, involving the dialogue-based perspective for design. My research demonstrated that supporting everyday practices with expressive wearable technology demands a particular perspective – one oriented toward the dynamics of socio-technical systems rather than interactive devices. From the explanations I uncovered for adornment practices, it is clear that wearable technology intended to become part of people's self-expression must provide freedom in the content and aesthetic forms permitted. Designers need to extend the associated perspective beyond strivings for open-endedness in the system or artefact designed; it must permeate the entire design process.

Finally, my findings pertaining to design approaches for adoption should not be regarded as without alternatives or as universal claims. Instead, I intend my efforts to highlight the complexity of designing augmented adornment and to respond to that complexity via one possible methodologically grounded way of studying technology: from a socio-cultural angle and with practices as the core element. Different settings and changes in cultural norms require adaptations to the process, as is only natural. However, the learning formulated through my project still should help future research contribute more fully to guiding principles and intermediate knowledge.

7. Discussion

The foregoing discussion has outlined how, together, the articles produced in the doctoral research answer the research questions, thereby enriching scholarly understanding of digitally augmented adornment practices and of design with both adoption and practices' evolution in mind. This chapter addresses how the answers found contribute to our body of knowledge and lays out their implications for theory, method, and practitioner application. I round out the chapter with reflections on the generalisability and positioning of the findings, presenting possible questions for future work on their basis.

Table 7.1. The project's aims and contributions

Aim	**Contribution**
Contextualise augmented adorning	- Present concrete adornment practices that involve digital artefacts - Identify the imperative of socio-cultural identity's meanings for performances with wearable technology - Show a link between digital phenomena and adornment practices (in memeing etc.)
Articulate adoption-oriented design guidance	- Develop a strong concept for design: Memetic Expression - Cultivate practices-oriented co-design and open-endedness to generate intermediate knowledge

7.1 Implications for HCI Research

Firstly, the RtD methodology of my work places the research results in the space at the intersection of practical and theoretical knowledge. Never intended for building novel theory, the project contributes most strongly through intermediate knowledge that bridges practice and theory. Table

7.1 summarises the outputs in line with the two central aims: 1) understanding expressive wearable technology as instantiating social practices of adornment and 2) generating design knowledge that can inform the adoption process. The subsections below tackle the implications of each of these contributions, in turn, for theory, method, and practitioner endeavours. I begin with what the findings pertaining to existing and emergent adornment practices with wearable technology imply. Then, I consider the corresponding design knowledge against a broader backdrop – i.e., in the context of the current landscape of design.

7.1.1 Integration of Adornment Practices and the Digital

My research answering RQ1 and RQ2 contextualised expressive wearable technology as a component of the social practice of augmented adornment. Over the past decade, ubiquitous information technologies have formed digital ecologies that extend to all facets of life. However, scholars' turn-of-the-millennium vision of wearable technology that enriches social life across the board has remained largely unfulfilled. To chase down its promise, I have argued for a shift in perspective – away from individual user interactions and toward ontologies that connect human technology-encompassing action with the structures that make up social life. Contemporary social-practice theories (T. Schatzki, 2016; Shove et al., 2012) provide tools for this shift.

My findings highlight that the changes appearing in adornment practices are linked to the technology-use practices of the day. Especially vividly, Publication V reports on phenomena whereby performers translate established practices of online-media use into specific face-to-face interactions and adornments. When confronted with the novel functionality of the interactive cloth patch, the students called upon their competencies from other digital environments.

While the project, in the case of memeing, formulated design knowledge suitable for use in such domains, plenty of other cultural practices anchored in online environments could spark similar developments. This implication points to a pattern of 'online' and 'offline' culture merging on a larger scale. In many online spaces, a culture of participation obtains priority over one of passive consumption. This marks a culture shift suggesting that users will demand greater ownership over elements of their adornment practices. Publication V considers the possible evolution of fashion designers' role in tandem with this, with specific regard to affording user participation in garments' production and looks. Competence in choosing the right outfit, from acquisition to wearing, forms a pillar of adornment, and it is fashion designers who still provide the garments and outfits. With social media, however, this space has become replete with influencers and with brands that accentuate dialogue with the customers.

Presenting results consistent with my findings, Skjulstad (2020) identified the 'fashion meme' as a tool for incipient branding and design efforts. Here, the designs and their depiction in social-media channels invite reaction, and the meme reactions inspire new designs in reciprocal dialogue that is evocative of the character of memes in digital culture. Given the novel materiality that digital technologies can provide (dynamic colours, active light, etc.), we can expect the roles of fashion designers and consumers alike to adjust in response. In particular, the versatility added by wearable computing brings various fabrication techniques within reach. Hence, the 'materials' part of the adornment practices is growing more malleable, with Mackey (2021, p. 173) emphasising on this basis that dynamic fabrics 'blend physical textiles with digital phenomena to create an entirely new material state'. Therefore, for any future-directed efforts, we *must* consider the materials of an augmented adornment practice as neither physical nor digital. They are both.

Links between adornment and digital practices are not limited to user-generated content. The spamming practice and the controversial concepts expressed by students (reported upon in publications V and IV, respectively) hint toward adaptations of questionable practices 'native to' online media. We need to problematise and examine how carrying such practices over into face-to-face interactions will dramatically affect social life.

Work prior to mine shed light on the attention economy's detrimental influence on human well-being, wrought as such social-media entities as Facebook, Instagram, and TikTok follow an economic model predicated upon keeping users engaged. Having pinpointed the paradox wherein employing proactive technology for joint engagement simultaneously increases technology-dependence, Dagan and colleagues(2019) advise designers to be careful in how they handle user time and attention. Beyond exacerbating this 'always-on' problem, online social-network platforms have perpetuated widespread trolling, polarisation, and hate speech (Mathew et al., 2019). Various such technologies have distorted/unravelled the fabric of society by dismantling safeguards and polarising public discourse. For example, critics have called Facebook to task for a clear role in genocidal actions against certain ethnic groups in Myanmar (Fink, 2018; Whitten-Woodring et al., 2020). In the course of identifying personal identity as crucial for practice under study and teasing out the adornment–digital-practices link, I found the clash between these phenomena more and more apparent. With distinction being so central to adornment, the disruptive characteristics of digital media possess vast potential for reinforcing this antagonism. In merely one example, one can easily imagine exploiting digital fabrics to trigger emotional reactions in bystanders. In conclusion, the trend of adornment coupled with digital practice manifests trajectories toward both desirable and troubling changes, which researchers, innovators, and other stakeholders all have to consider.

In addition to spotlighting the implications of merging analogue and digital practices, my theoretical framing of adornment draws social context into focus. The framing places technology among all the adornment practice's components and transcends the limitations of current classifications of context. Studies probing social matching have distinguished among personal, relational, and social contexts, yet work by Mayer et al. (2016) on contextual social matching clarifies that these context categories are hard to separate. Finding them interconnected, the Mayer's team concluded that no operationalisation of context is sufficient for predicting opportunities for social engagement. The literature on social acceptability offers no real way forward either, as it operationalises context via rather open-ended dimensions of audience and location (Koelle et al., 2020).

Publication I highlights the limitations of such typical approaches. The most promising occurrences of augmented adornment, in contrast, came in connection with specific activities. For example, an organised event constituted an occasion for people to meet in the bar location, where we encountered them aligned accordingly for the sticker study. In contrast, participants at the library had arrived for disparate activities so differed in their interpretations of our probe's usefulness. Correspondingly, the greatest willingness to meet someone in the Mayer group's study was correlated with a constellation of contextual factors around a specific activity: playing a video game, studying, or going out for drinks (Mayer et al., 2016, p. 2437). These findings support Dourish (2004a)'s assertion that context of use is what people do, while the foreground practices function as a theoretical construct for study and analysis of ubiquitous technologies.

To demonstrate and pave the way for such analysis, I have presented evidence of the adornment practices' dynamics and of their relations to digital technologies. Centring on practices resolves the dichotomy between user interactions and their context. The model I developed, building on Shove et al. (2012)'s framing, helps render the manifold dimensions by which we define social context – audience, locality, etc. – manageable by simplifying them into core sets of elements: meanings, materials, and skills. In the study behind Publication I, this stands out with regard to the place category. Rather than take location as one determinant for user behaviour, we can articulate a location's expression in the physical space as infrastructure (as in material) and approach the meanings associated with using that place as another element. Returning to the example of the library, we find that the activity of focused studying implies strikingly different meanings ascribed to the location relative to those assigned by people who were waiting there or passing by. The theoretically oriented shift illustrated here should help designers and researchers alike discuss social wearables in terms of the real-world dynamics of people's life.

The dissertation project accentuated another advantage of this perspective, evident in my finding that identities are crucial in augmenting of adornment practices. This is consistent with related work demonstrating how numerous aspects of social context all tie in with the self-identification process. For example, personal context is linked to self-image and to the roles played in the associated audiences and public spaces. Accordingly, this dissertation has repeatedly stressed the importance of identity and aesthetics with specific regard to wearables and clothing (see chapters 4 and 5 especially). The explanation proffered here conceptualises identity and aesthetics as meanings constitutive to adornment practices. Understanding social context in terms of identity-related meanings helps reveal how dynamics of self-identification affect behaviour. In that meanings bound up with identity are indispensable to any adornment practice, those meanings show intimate ties to sustaining the practice. For example, one might regard the public context of a bus stop as infrastructural but additionally, it conveys a meaning. The bus stop is connected to the performance: this public space shared with people outside one's social group demands blending in and not imposing oneself on others (see Publication I, p. 196). Hence, we can view the non-material meanings, which we would normally view as contextual factors, as indispensable elements of performing adornment.

In sum, my empirical findings confirm how approaching augmented adornment as a social practice opens a fruitful new perspective on technology for collocated social interactions and wearable technology. Coupled with the above-mentioned contributions to scholarship, these findings support the practical undertakings of designers and design researchers, which I address next.

7.1.2 Cultivating Intermediate Knowledge for Social Wearable Design

Because the doctoral project was set primarily in the HCI domain, much of the effort revolved around questions of designing technology. The theoretical implications of conceptualising augmented adornment do not directly translate into knowledge for design – translation requires 'methods, concepts and analytic tools' (Rogers, 2012, p. 84) – so I must demonstrate the findings' part in generating the necessary intermediate knowledge (Höök & Löwgren, 2012).

Recent decades have witnessed significant efforts to develop frameworks and guidelines for embedding wearable technology in our social interactions. I argue, however, that the dominant technique – mapping designs for social acceptability – reinforces existing stereotypes and injustice through social pressure. In fact, my conclusion meshes well with a concern that has become central for the discipline with the advent of consumer-friendly solutions based on machine learning (face recognition, large language mod-

els, etc.): biases in algorithmic systems. Repeatedly, such systems have shown themselves reinforcing racial or gender bias, for instance. Some have suffered from biases in their training data, others have drifted into inappropriate behaviour, and recent developments in machine learning illustrate not only that conversational agents can easily be manipulated to repeat antisemitic or racist speech (Bender et al., 2021) but also that users have encountered transgressive behaviour by these agents in the wild (as Cole, 2023, has highlighted in the case of the popular mental-health chat service Replika).

My proposal for a dialogue-based perspective enhances the debate connected with practical adoption of tech fashion and social wearables. Let us consider the recommendation that designs avoid women's upper chest area. As the inconclusive results cited in subsection 2.2.1 attest, there is an immensely context-dependent aspect to whether the female chest gets accepted as a place for a wearable (Genç et al., 2022). This design suggestion and recommendations to avoid the area around the genitalia become particularly fraught in light of today's unresolved questions of gender norms and equality. Alongside cultural and other contextual factors, the picture is complicated by sexual norms that are in constant flux. Highlighting the complexity surrounding the female chest area, an incident in Berlin in 2021 reignited debate in Germany about the legal status of women exposing their breasts in public (Schmidt, 2021). With some activists arguing that current interpretations of laws restrict women's rights unequally and sexualise the female breast (in that women are often prohibited from baring their chest in public places where men are not), some public swimming halls in Germany responded by permitting any patron's chest to go uncovered in the following summer (Hildebrandt, A., 2022). In such fluid conditions, designers cannot rely on some assumed static norm of social acceptability if wishing to design truly dynamic fabrics and reactive fashion. The question, then, of where on the body to place a wearable hinges not on generalised body maps but on the practices people seek to perform with the technology at issue. Whichever aspect of social life said technology might augment, to whatever extent, it is woven into many of the practices that make up people's everyday life.

With the problem cast as designing a fluid process, as opposed to setting a technology in place, intermediate knowledge is pivotal – we must connect designing for the context of mediated social interactions to the particularities of performative bodily expressions. Designing for augmented adornment entails designing for a new practice. Health wearables provide a starting point. They have become increasingly fashionable in recent years, and the HCI field's design approaches seem fruitful. While these efforts remain focused on existing adornments (with rings, handbags, shirts, and other such garments), research designs have exhibited an active stance to augment social interactions or make the fashion itself reactive.

Active adornments imply fundamentally different meanings. Still, the researchers have rarely sought a deeper understanding of people's practices. It is clear, therefore, that we must engage in further study of how augmented adornment unfolds, with special emphasis on practice beyond 'carrying accessories', 'covering the body', or 'social signalling'. Such work should afford a transition toward a genuine participatory culture in the wearables domain.

To sow seeds for more intermediate knowledge, I have proposed both a dialogue-based perspective and methods adapted to be oriented toward practices (see Section 6.2 in particular). The first step toward this is the strong concept of Memetic Expression, which I have introduced to furnish guiding principles for navigating the hybrid space of mediated social interactions and wearable technologies. This concept is grounded in existing understanding of memes in digital culture and in empirical findings from the fieldwork. While further study is required – after all, no clear generative theory thus far has grappled with how to design a system that exploits mimetic expressions – these underpinnings render it a valuable contribution to interaction-design knowledge. The examples of image macros and mimetic short-video platforms such as TikTok notwithstanding, its generative qualities do need further evidence from purposefully applying the concept in design, though. Because the scope of a strong concept extends beyond any specific application, it remains to be seen whether the concept functions well for interaction design beyond augmenting boiler-suit adornment. This avenue is ripe for exploration, since scholars have started drawing a connection between memes and affective design (Brown et al., 2022).

Just as a strong concept cannot stand in isolation, the dialogue-oriented perspective is enmeshed in the HCI field's general discussion. Over the last two decades, HCI research has introduced various concepts that refer to openness and dialogue. My findings point the way toward investigating these approaches in a manner suited to the design of social wearables.

Ambiguity offers one valuable tool for this. Through it, practitioners stay more open to diverse interpretation and users are better equipped to create meaning. While ambiguity has been mentioned in the context of wearables (Devendorf et al., 2016; Howell et al., 2018), a much larger body of design knowledge exists. Among the contributors, Sengers and Gaver (2006) formulated strategies that employ seamful design to make systems more transparent. At the same time, work on appropriation has encouraged developing solid design guidelines. One example comes from how Höök (2006), working with scholarly notions of surfaces offered by Suchman (Suchman, 2007) defined familiar open surfaces. In their reflection on two expressive interactive systems, Höök even cites the metaphor of people adjusting clothing to align with their needs.

Secondly, open-endedness allows for variety in how users engage with

a given system. Jin-min et al. (2014) have captured this in their descriptions of how intentionally unfinished products empower users for creative problem-solving. Building on these, Boon et al. (2018) integrated open-endedness and ambiguity into their setting to support designing for behaviour change. They highlighted in particular that open-endedness need not act against providing direction toward the overarching design goal. In their design case, which has some general properties in common with the setting for the doctoral project's final intervention, they used spontaneous, unstructured play to support physical activity within the limits of a children's hospital.

If we now turn our attention to the larger shift toward participatory culture in relation to wearables, we can draw from an even larger body of accumulated knowledge, the extensive understanding arising from the accessibility of open software design. A case in point is visible in the parallels between my depiction of a practices-oriented research approach and the framework of meta-design (Fischer & Giaccardi, 2006). The similarities stem from the framings. By framing social wearables as artefacts integrated into an augmented adornment practice, I set the conceptualisation of wearable technology within the context of socio-technical systems, and it is socio-technical systems that advocates of meta-design aim to develop by building on the large body of research on collaborative software development. To this end, they have proposed a set of concepts and a long-term process that, by bringing co-creation and continuous development into the design, form a bridge between 'design before use' and 'design in use'. Meta-design has already served applications that feature wearable technologies (Fischer, 2011); however, practitioners have not yet put it to use for designing social wearables or for cases of augmented adornment. The dialogue-based perspective that I propose opens social wearables' design to such angles of inquiry as the landscape of 'open design' and related methods (Wood, 2022) continues to evolve.

Social-practices theories model how practices emerge, are sustained, and die. Knowing about practices helps us design for the long term. For example, environmental and social sustainability have attracted attention as worthy of design focus in the last few years. Translating practice-related thinking into contributions to augmented adornment in combination with a solid understanding of open-endedness and frameworks such as meta-design aids in identifying implications for adoption. Designers who operate from these foundations can be more proactive in their practical efforts to address such critical factors in the wearable technologies that emerge for social interaction and augmenting appearance.

7.2 Reflections on Generalisability and Positionality

While showing several patterns across human culture, adornment practices display a myriad of variations, too. The cases examined here are limited to the North-Western European culture of Finland, and the central case study zeroed in still further on a Finnish university environment connected to engineering. Such a student culture follows traditions of exclusion in its sphere of social norms and discourse. Some traditions of engineering, terms such as 'brotherhood', etc. attest to propagation of white cisgender men's influence here, with several aspects of this phenomenon manifesting themselves during my fieldwork. Widespread continued discrimination had prompted criticism of student-association officials for openly embracing colonialist stereotypes (El Kamel, 2018), and in 2020 this culminated in the local student union withdrawing its official songbook because of racist tropes in several songs (Aalto University Student Union, 2020). Simultaneously, challenges to equality reasserted themselves, as evidenced by some 'secret societies' that did not admit non-males as members (Harju & Rautio, 2018).

These tensions bear direct connections to internal conflicts facing me as a researcher. While all the work behind this doctoral thesis has been documented thoroughly, the RtD- and case-study-based methodology represented relies heavily on the individual human researcher. An incident during one of my field visits exemplifies the attendant issues well: an informant was eager to 'not' hand me a booklet containing all the songs removed from the official student songbook. This left me conflicted, since I was pleased to be included in the 'inner circle' aware of this booklet that had 'never' been printed while at the same time despising the reproduction of harmful stereotypes. The experience foregrounds my position as a person entangled in social structures. I struggled with tensions of inclusion and exclusion throughout the boiler-suit research. As is natural in ethnographic work, the access necessary for my research entailed questions of balance and attempting to understand my own distinct standpoint. Although being a white cisgender male conferred the privilege of 'fading in' without facing any initial discrimination as I began mingling with the students, I recognised distance from other angles. As a foreigner from Germany, I found that the language barrier made it tricky to dive more deeply without exerting additional effort. Crucially, cultural expectations came into play for me also. In Germany, student unions often operate in nationalist circles, so the explicitly assertive facet to the overalls and depictions appeared odd to me. Having keenly sensed this initial peculiarity, even slight aversion, I was able to reocgnise how it vanished the first time I wore my own boiler suit and, with Publication IV, report on the phenomenon whereby slipping into the spacious garment allowed me to fall into a role that emulated the students' experiences. Importantly,

the contrast itself proved valuable too. Being concerned about exclusion helped to overcome the feeling of detachment that may be tempting for a seemingly objective observer. The resulting balance helped me respect the complexity of the cultural context.

It was that aim itself – to value cultures' rich variety – that drove me to study this particular culture and, more generally, the topic of augmented adornment. My education and experience shaped a sense in me that social life should not be reduced to dualistic constructs, such as 'good' vs. 'bad' culture, or subjected to quantitative metrics for interaction – e.g., instruments echoing a belief-based assumption that people are lonely because they lack social contacts. As I engaged in participatory research aimed at making people heard, my position of privilege as a cisgender white male weighed heavily on me. That position inherently limited how well I could capture the perspective of women and various other groups both external to and within the student culture under study. However, my design background sensitised me at the level of the overall goal, remedying some of these concerns. I found the pleasure that participants gained from my interventions especially heartening, and I welcomed how they empowered the students to take ownership of their expression by means of digital technology.

7.3 Limitations and Questions for Future Work

From the personal standpoint reflected upon above, certain limitations of the work are highly apparent. These represent opportunities for further investigation, and I draw attention to them accordingly. The primary consideration in this regard is that all of my findings are circumscribed by the methods chosen in the doctoral project. Co-design might have reinforced the designers' and students' beliefs to such an extent that these are difficult to separate from the empirical findings. Furthermore, while I employed speculative methods to anticipate developments beyond the obvious, the outcomes cannot be legitimately seen as predictions of changes.

7.3.1 The Work's Scope

The students participating in the design intervention were sampled from a much larger population. With prototype-based research limited to such a small sample, it was impossible to study any larger effects in the student network as a whole. One critical note about the results presented in the dissertation emerged from reflecting on the approach behind Publication III: study of how practices with technology evolve through time. Though the research team engaged with participants in the field for around 11 weeks in the study presented in Publication V, routine practices often develop

over far longer (at least six months). Since the doctoral research dealt with the dynamics of people's practices, as they unfold, further validating studies are necessary.

7.3.2 Power and Control

The examples of *crowd-sourced safety* cited in Publication IV and the tension around spamming spotlighted in Publication V illuminate forces that thwart traditional mechanisms of power and control to a considerable degree. Presenting similar challenges, Mackey et al. (2017) described the loss of control encountered when a co-worker imposed particular vestments on the paper's first author by using the 'green-screen' technology on his mobile phone:

> I observed that my transition from the original all-green dress to a wardrobe containing varying amounts of green was one way of 'protecting' myself from these kinds of 'digital attacks.' (p. 58)

This leads us to ask how people can actively control these augmentations. To this end, Dagan, Márquez Segura, Altarriba Bertran, Flores, and Isbister (2019) investigated how vulnerability may serve as a resource for a social wearable's design. In particular, if regarding automated systems as co-performers (Kuijer & Giaccardi, 2018), we must attend to the matter of mediating the power and control connected with self-expression.

> Striking the right balance between sensing and actuation, as well as carefully distributing power between human and non-human actors, is key to establishing a positive feedback loop between fashion technology and its wearers. (Toussaint & Toeters, 2020, p. 2237)

The openness exploited in the work for Publication V gave the more tech-savvy an advantage – they had greater ability to circumvent the device's limitations. Even the language of calling Digi Merkki a 'social lubricant' points to safety implications. Although this characterisation was intended to be a positive one, detecting a parallel to social lubricants such as alcohol is unavoidable. Alcohol's centrality to student practices (bound up with its overall prominence in patterns of socialisation in Western cultures) is unequivocal linked with the problems of substance abuse (Yle News, 2022). In my case, the community-oriented approach aided in negotiating practices to balance those tensions. However, the non-judgemental context of the research provided a 'safe space' also. Any goal of larger-scale adoption of augmented adornment necessitates devoting serious consideration to equal access for managing acceptability and misuse issues, with attention not just to the design problem of control but also, ultimately, to questions

of power (Lindley et al., 2017). For stakeholders considering the broader implications of production and consumption of fashion, framing augmented adornment as a cultural practice should supply entry points for nurturing sustainable practices on the part of actors besides the established players in the fashion industry (Pan et al., 2012).

7.3.3 Non-Western Cultures and Dress Practices

Power over novel augmented adornment is linked also to positioning in relation to the global North. In this respect, the doctoral research's setting, particularly in a Nordic country, may be aligned with a pattern in which non-white and non-Western perspectives are 'missing equity in terms of access and representation in technology design and development' (Borsotti & Bjørn, 2022, p. 772). The technologies developed in the global North influence ongoing globalisation, propelling a process of integration through which societies worldwide affect dress and fashion culture in particular ways. In light of my findings attesting to how dress and digital practices merge, then, we can conclude that the imbalance in control over the adoption of augmented adornment is even more significant than it may at first seem. To mitigate the colonisation of dress cultures and appreciate new perspectives on adopting expressive technologies in our social dealings, factoring in adornment practices from the global South should yield benefits. This is not least because cultures that practise adornment on the basis of differing values might well differ in their ways of adapting to given technological tools. For example, a less individualistic performance of adornment might exhibit lower barriers to adoption than performances in settings more typically considered in scholarly work, my own work included. Even when cultivating the desired perspective by delving into the local cultural context, the project did not direct great attention to those people *not* engaging in the boiler-suit practices or to the effects on their life.

7.3.4 Intermediate Knowledge through Open-Endedness

One implication of the findings presented here is that further research should expand our perspective through awareness of the strong relationship between wearable computing and meanings of identity, coupled with a solid understanding of digital and analogue practices' gradual linking as an entry point for adoption. It bears reiterating especially that Memetic Expression's generative quality and its connection to affective design merit further investigation. Scholarship should cultivate greater understanding of whether stressing acceptability concerns might hamper innovation but also examine whether the concepts proposed in this thesis can function as tools for overcoming such impediments. I recommend, in conjunction

with that future work, striving to identify additional guiding principles whereby designers can derive benefits from bottom-up social organisation. My findings in support of open-endedness pave the way for design research encompassing a vast space for exploration. Enquiries specific to other distinct practices, alongside conceptualising practices that exert a linking effect through open-endedness and co-creative design, might well lead to a more comprehensive design theory rooted in open-endedness.

The doctoral research represents empirical and methodological contributions to a solid understanding of both studying and designing wearable technology in the context of augmenting appearance. Connecting social-practice theories to techno-fashion and technologies for collocated social interaction, with articulation of the findings across five publications, has revealed vital implications for the HCI discipline and beyond.

References

Aalto University Student Union. (2020, June 12). *AYY tackles racism in its community – technical students' songbook withdrawn from the market*. Retrieved April 7, 2023, from https://www.ayy.fi/en/ayy-tackles-racism-in-its-community-technical-students-songbook-withdrawn-from-the-market

Barnard, M. (2014, March 26). *Fashion Theory*. Routledge. https://doi.org/10.4324/9780203862100

Baskerville, R. L., & Myers, M. D. (2015). Design ethnography in information systems. *Information Systems Journal*, *25*(1), 23–46. https://doi.org/10.1111/isj.12055

Bender, E. M., Gebru, T., McMillan-Major, A., & Shmitchell, S. (2021). On the dangers of stochastic parrots: Can language models be too big? *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency*, 610–623. https://doi.org/10.1145/3442188.3445922

Berglin, L. (2013). *Smart textiles and wearable technology*. Högskolan i Borås.

Berzowska, J. (2005). Electronic textiles: Wearable computers, reactive fashion, and soft computation. *TEXTILE*, *3*(1), 58–75. https://doi.org/10.2752/147597505778052639

Bødker, S., & Kyng, M. (2018). Participatory design that matters – facing the big issues. *ACM Transactions on Computer–Human Interaction*, *25*(1). https://doi.org/10.1145/3152421

Boon, B., Rozendaal, M. C., & Stappers, P. J. (2018). Ambiguity and open-endedness in behavioural design. *Proceedings of DRS 2018*, 2075–2085. https://doi.org/10.21606/drs.2018.452

Borovoy, R., Martin, F., Vemuri, S., Resnick, M., Silverman, B., & Hancock, C. (1998). Meme tags and community mirrors: Moving from conferences to collaboration. *Proceedings of the 1998 ACM Conference on Computer Supported Cooperative Work*, 159–168. https://doi.org/10.1145/289444.289490

Borsotti, V., & Bjørn, P. (2022). Humor and stereotypes in computing: An equity-focused approach to institutional accountability. *Computer Supported Cooperative Work (CSCW)*, *31*(4), 771–803. https://doi.org/10.1007/s10606-022-09440-9

Bottero, W. (2015). Practising family history: 'Identity' as a category of social practice. *The British Journal of Sociology*, *66*(3), 534–556. https://doi.org/10.1111/1468-4446.12133

Bourdieu, P. (1990). *In other words: Essays towards a reflexive sociology*. Stanford University Press.

Bourdieu, P., & Nice, R. (2008). *Distinction: A social critique of the judgement of taste*. Routledge.

Braun, V., & Clarke, V. (2020). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, *18*(3), 328–352. https://doi.org/10.1080/14780887.2020.1769238

Brown, Y., Pini, B., & Pavlidis, A. (2022). Affective design and memetic qualities: Generating affect and political engagement through bushfire TikToks. *Journal of Sociology*, *57*(4), 969–985. https://doi.org/10.1177/14407833221110267

Brun, D., & Häkkilä, J. (2021). VäriWig: Interactive coloring wig module. *ISWC '21: Proceedings of the 2021 ACM International Symposium on Wearable Computers*, 166–169. https://doi.org/10.1145/3460421.3478832

Bruner, E. M. (1986). Experience and its expressions. In *The anthropology of experience* (pp. 3–32, Vol. 3). University of Illinois Press.

Buchenau, M., & Suri, J. F. (2000). Experience prototyping. *Proceedings of the 3rd Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques*, 424–433. https://doi.org/10.1145/347642.347802

Chang, W.-C., & Lin, R.-T. (2020). Designing for wearable and fashionable interactions: Exploring narrative design and cultural semantics for design anthropology. *Interaction Studies*, *21*(2), 200–219. https://doi.org/10.1075/is.17047.cha

Charara, S. (2016, January 14). *Gemio: Smart bracelet light messages are the new Snapchat*. Wareable. Retrieved February 7, 2019, from https://www.wareable.com/fashion/gemio-smart-bracelet-light-messages-new-snapchat

Chen, J., & Abouzied, A. (2016). One LED is enough: Catalyzing face-to-face interactions at conferences with a gentle nudge. *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing – CSCW '16*, 172–182. https://doi.org/10.1145/2818048.2819969

Cole, S. (2023, January 12). *'My AI is sexually harassing me': Replika users say the chatbot has gotten way too horny*. Vice. Retrieved January

16, 2023, from https://www.vice.com/en/article/z34d43/my-ai-is-sexually-harassing-me-replika-chatbot-nudes

Collective, P. (2018, January 15). *Pins Collective*. Kickstarter. Retrieved October 13, 2020, from https://www.kickstarter.com/projects/pinscollective/pins-collective

Colley, A., Pakanen, M., Koskinen, S., Mikkonen, K., & Häkkilä, J. (2016). Smart handbag as a wearable public display – exploring concepts and user perceptions. *AH '16: Proceedings of the 7th Augmented Human International Conference*. https://doi.org/10.1145/2875194.2875212

Colley, A., Pfleging, B., Alt, F., & Häkkilä, J. (2020). Exploring public wearable display of wellness tracker data. *International Journal of Human–Computer Studies*, *138*. https://doi.org/10.1016/j.ijhcs.2020.102408

Crane, D. (2000). *Fashion and its social agendas: Class, gender, and identity in clothing*. University of Chicago Press.

Dagan, E., & Isbister, K. (2021). Synergistic social technology: Designing systems with 'needs' that encourage and support social interaction. *DIS '21: Proceedings of the 2021 ACM Designing Interactive Systems Conference*, 1419–1432. https://doi.org/10.1145/3461778.3462021

Dagan, E., Márquez Segura, E., Altarriba Bertran, F., Flores, M., & Isbister, K. (2019). Designing 'True Colors': A social wearable that affords vulnerability. *CHI '19: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/3290605.3300263

Dagan, E., Márquez Segura, E., Altarriba Bertran, F., Flores, M., Mitchell, R., & Isbister, K. (2019). Design framework for social wearables. *DIS '19: Proceedings of the 2019 ACM Designing Interactive Systems Conference*, 1001–1015. https://doi.org/10.1145/3322276.3322291

Dagan, E., Márquez Segura, E., Flores, M., & Isbister, K. (2018). 'Not too much, not too little' wearables for group discussions. *CHI 2018: Extended abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*, LBW129:1–LBW129:6. https://doi.org/10.1145/3170427.3188500

Desmet, P., & Hassenzahl, M. (2012). Towards happiness: Possibility-driven design. In M. Zacarias & J. V. de Oliveira (Eds.), *Human–computer interaction: The agency perspective* (pp. 3–27). Springer. https://doi.org/10.1007/978-3-642-25691-2_1

Devendorf, L., Ryokai, K., Lo, J., Howell, N., Lee, J. L., Gong, N.-W., Karagozler, M. E., Fukuhara, S., Poupyrev, I., & Paulos, E. (2016). 'I don't want to wear a screen': Probing perceptions of and possibilities for dynamic displays on clothing. *CHI '16: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 6028–6039. https://doi.org/10.1145/2858036.2858192

Dibia, V. (2015). An affective, normative and functional approach to designing user experiences for wearables. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2630715

Dierk, C., Nicholas, M. J. P., & Paulos, E. (2018). AlterWear: Battery-free wearable displays for opportunistic interactions. *CHI '18: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/3173574.3173794

Dierk, C., Sterman, S., Nicholas, M. J. P., & Paulos, E. (2018). HäirIÖ: Human hair as interactive material. *TEI '18: Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction*, 148–157. https://doi.org/10.1145/3173225.3173232

Dourish, P. (2004a). What we talk about when we talk about context. *Personal and Ubiquitous Computing*, *8*(1), 19–30. https://doi.org/10.1007/s00779-003-0253-8

Dourish, P. (2004b). *Where the action is: The foundations of embodied interaction* (1st paperback ed.). MIT Press.

Dourish, P. (2014). Reading and interpreting ethnography. In *Ways of knowing in HCI* (pp. 1–23). Springer. https://doi.org/10.1007/978-1-4939-0378-8

Dourish, P., & Bell, G. (2011). *Divining a Digital Future: Mess and Mythology in Ubiquitous Computing*. MIT Press.
OCLC: 743012406.

Dunne, A., & Raby, F. (2013). *Speculative everything: Design, fiction, and social dreaming*. MIT Press.

Dunne, L. (2010). Smart clothing in practice: Key design barriers to commercialization. *Fashion Practice*, *2*(1), 41–65. https://doi.org/10.2752/175693810X12640026716393

Dunne, L., Profita, H., & Zeagler, C. (2014). Social aspects of wearability and interaction. In *Wearable sensors* (pp. 25–43). Elsevier. https://doi.org/10.1016/B978-0-12-418662-0.00026-X

El Kamel, S. (2018, February 8). *Inside joke*. Ylioppilaslehti Aino. Retrieved April 7, 2023, from https://ainolehti.fi/aino/inside-joke/

Entwistle, J. (2015). *The fashioned body: Fashion, dress and modern social theory* (2nd ed.). Polity Press.

Fairburn, S., Steed, J., & Coulter, J. (2016). Spheres of practice for the co-design of wearables. *Journal of Textile Design Research and Practice*, *4*(1), 85–109. https://doi.org/10.1080/20511787.2016.1255445

Falk, J., & Björk, S. (1999). The BubbleBadge: A wearable public display. *CHI EA '99: CHI '99 extended abstracts on human factors in computing systems*, 318–319. https://doi.org/10.1145/632716.632909

Fallman, D. (2011). The new good: Exploring the potential of philosophy of technology to contribute to human–computer interaction. *CHI '11: Proceedings of the SIGCHI Conference on Human Factors in*

Computing Systems, 1051–1060. https://doi.org/10.1145/1978942.1979099

Farnham, S. D., & Churchill, E. F. (2011). Faceted identity, faceted lives: Social and technical issues with being yourself online. *CSCW '11: Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work*, 359–368. https://doi.org/10.1145/1958824.1958880

Fink, C. (2018). Dangerous speech, anti-Muslim violence, and Facebook in Myanmar. *Journal of International Affairs*, *71*(1.5), 43–52.

Fischer, G. (2011). Social creativity: Exploiting the power of cultures of participation. *SKG '11: Proceedings of the 2011 Seventh International Conference on Semantics, Knowledge and Grids*. https://doi.org/10.1109/SKG.2011.47

Fischer, G., & Giaccardi, E. (2006). Meta-design: A framework for the future of end-user development. In H. Lieberman, F. Paternò, & V. Wulf (Eds.), *End User Development* (pp. 427–457). Springer Netherlands. https://doi.org/10.1007/1-4020-5386-X_19

Flick, U. (2009). *An introduction to qualitative research* (4th ed.). SAGE Publications.

Frayling, C. (1993). Research in art and design. *Royal College of Art Research Papers*, *1*(1). https://researchonline.rca.ac.uk/384/3/frayling_research_in_art_and_design_1993.pdf

Garfinkel, H. (1984). *Studies in ethnomethodology*. Polity Press.

Gaver, W. W., Beaver, J., & Benford, S. (2003). Ambiguity as a resource for design. *CHI '03: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 233–240. https://doi.org/10.1145/642611.642653

Gaver, W. W., Boucher, A., Pennington, S., & Walker, B. (2004). Cultural probes and the value of uncertainty. *Interactions*, *11*(5), 53–56. https://doi.org/10.1145/1015530.1015555

Genç, Ç., Raudanjoki, Ö., Colley, A., & Häkkilä, J. (2022). Augmenting human appearance through technological design layers. *Frontiers in Computer Science*, *4*. Retrieved April 12, 2022, from https://www.frontiersin.org/article/10.3389/fcomp.2022.755451

Goffman, E. (1959). *The presentation of self in everyday life*. Doubleday.

Goffman, E. (1966). *Behavior in public places: Notes on the social organization of gatherings* (1st paperback ed., 24th printing). The Free Press.

Gold, R. L. (1958). Roles in sociological field observations. *Social Forces*, *36*(3), 217–223. https://doi.org/10.2307/2573808

Grubert, J., Kranz, M., & Quigley, A. (2016). Challenges in mobile multi-device ecosystems. *mUX: The Journal of Mobile User Experience*, *5*(1). https://doi.org/10.1186/s13678-016-0007-y

Häkkilä, J. (2017). Designing for smart clothes and wearables – user experience design perspective. In S. Schneegass & O. Amft (Eds.), *Smart textiles: Fundamentals, design, and interaction* (pp. 259–278). Springer International. https://doi.org/10.1007/978-3-319-50124-6_12

Häkkilä, J., Colley, A., Roinesalo, P., & Väyrynen, J. (2017). Clothing integrated augmented reality markers. *MUM '17: Proceedings of the 16th International Conference on Mobile and Ubiquitous Multimedia*, 113–121. https://doi.org/10.1145/3152832.3152850

Halse, J., & Boffi, L. (2016). Design interventions as a form of inquiry. In *Design Anthropological Futures: Exploring Emergence, Intervention and Formation* (1st ed., pp. 89–103). Bloomsbury Academic. https://doi.org/10.4324/9781003085188

Harju, E., & Rautio, S. (2018, March 30). *Aalto-yliopiston salaperäinen "luolamieskilta" kelpuuttaa jäsenikseen vain miehiä - Miten yhteistyö istuu tasa- arvoperiaatteisiinne, Marimekko?* Iltalehti. Retrieved October 10, 2019, from https://www.iltalehti.fi/kotimaa/a/201803292200846550

Harjuniemi, E., Colley, A., Rytilahti, P., & Häkkilä, J. (2020). IdleStripes shirt – wearable display of sedentary time. *PerDis '20: Proceedings of the 9th ACM International Symposium on Pervasive Displays*, 29–36. https://doi.org/10.1145/3393712.3395340

Harjuniemi, E., Colley, A., Rytilahti, P., Li, H., Forest, J., & Häkkilä, J. (2018). Idle Stripes Shirt: Ambient Wearable Display for Activity Tracking. *Proceedings of the 2018 ACM International Symposium on Wearable Computers*, 254–259. https://doi.org/10.1145/3267242.3267303

Harvey, L. J., & Myers, M. D. (1995). Scholarship and practice: The contribution of ethnographic research methods to bridging the gap. *Information Technology & People*, *8*(3), 13–27. https://doi.org/10.1108/09593849510098244

Hildebrandt, A. (2022, September 15). *Gleiche Brust für alle? Frau kämpft vor Gericht um ihr Recht auf "oben ohne"*. T-Online. Retrieved January 12, 2023, from https://www.t-online.de/-/100052580

Hirskyj-Douglas, I., Kytö, M., & McGookin, D. (2019). Head-mounted displays, smartphones, or smartwatches? – Augmenting conversations with digital representation of self. *Proceedings of the ACM on Human–Computer Interaction*, *3*, 179:1–179:32. https://doi.org/10.1145/3359281

Hobye, M., & Löwgren, J. (2011). Touching a stranger: Designing for engaging experience in embodied interaction. *International Journal of Design*, *5*(3), 31–48.

Höök, K. (2006). Designing familiar open surfaces. *NordiCHI '06: Proceedings of the 4th Nordic Conference on Human–Computer Interaction: Changing roles*, 242–251. https://doi.org/10.1145/1182475.1182501

Höök, K., Bardzell, J., Bowen, S., Dalsgaard, P., Reeves, S., & Waern, A. (2015). Framing IxD knowledge. *Interactions*, *22*(6), 32–36. https://doi.org/10.1145/2824892

Höök, K., & Löwgren, J. (2012). Strong concepts: Intermediate-level knowledge in interaction design research. *ACM Transactions on Computer–Human Interaction*, *19*(3), 23:1–23:18. https://doi.org/10.1145/2362364.2362371

Horst, H. A., Baylosis, C., & Mohammid, S. (2021). Looking professional: How women decide what to wear with and through automated technologies. *Convergence*, *27*(5), 1250–1263. https://doi.org/10.1177/13548565211038520

Howell, N., Devendorf, L., Vega Gálvez, T. A., Tian, R., & Ryokai, K. (2018). Tensions of Data-Driven Reflection: A Case Study of Real-Time Emotional Biosensing. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–13. https://doi.org/10.1145/3173574.3174005

Iivari, N., Kinnula, M., Kuure, L., & Keisanen, T. (2020). 'Arseing around was fun!' – humor as a resource in design and making. *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*.

Inget, V., Müller, H., & Häkkilä, J. (2019). Private and public aspects of smart jewellery: A design exploration study. *MUM '19: Proceedings of the 18th International Conference on Mobile and Ubiquitous Multimedia*, 19:1–19:7. https://doi.org/10.1145/3365610.3365613

Isbister, K., Abe, K., & Karlesky, M. (2017). Interdependent wearables (for play): A strong concept for design. *CHI '17: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 465–471. https://doi.org/10.1145/3025453.3025939

Ito, M., Okabe, D., & Anderson, K. (2009). Portable objects in three global cities: The personalization of urban places. In R. Ling & S. W. Campbell (Eds.), *The reconstruction of space and time: Mobile communication practices* (pp. 67–87).

Jarusriboonchai, P., & Häkkilä, J. (2019). Customisable wearables: Exploring the design space of wearable technology. *Proceedings of the 18th International Conference on Mobile and Ubiquitous Multimedia - MUM '19*, 1–9. https://doi.org/10.1145/3365610.3365635

Jarusriboonchai, P., Malapaschas, A., Olsson, T., & Väänänen, K. (2016). Increasing collocated people's awareness of the mobile user's activities: A field trial of social displays. *CSCW '16 Companion: Proceedings of the 19th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 1691–1702. https://doi.org/10.1145/2818048.2819990

Jin-min, S., Jong-bum, W., & Youn-kyung, L. (2014). Non-finito products: A new design space of user creativity for personal user experience.

CHI '14: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 693–702. https://doi.org/10.1145/2556288.2557222

Johnson, R., Rogers, Y., van der Linden, J., & Bianchi-Berthouze, N. (2012). Being in the thick of in-the-wild studies: The challenges and insights of researcher participation. *CHI '12: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1135–1144.

Jokela, T., Chong, M. K., Lucero, A., & Gellersen, H. (2015). Connecting devices for collaborative interactions. *Interactions*, *22*(4), 39–43. https://doi.org/10.1145/2776887

Jonathan Lazar, Jinjuan Heidi Feng, & Harry Hochheiser. (2017). *Research methods in human–computer interaction* (2nd ed.). Elsevier.

Juhlin, O. (2015). Digitizing fashion: Software for wearable devices. *Interactions*, *22*(3), 44–47. https://doi.org/10.1145/2754868

Jumisko-Pyykkö, S., & Vainio, T. (2012). Framing the context of use for mobile HCI. In J. Lumsden (Ed.), *Social and organizational impacts of emerging mobile devices: Evaluating use* (pp. 217–219). IGI Global.

Kao, H.-L. C. (2021). Hybrid body craft: Toward culturally and socially inclusive design for on-skin interfaces. *IEEE Pervasive Computing*, *20*(3), 41–50. https://doi.org/10.1109/MPRV.2021.3079321

Kao, H.-L. C., Ajilo, D., Anilionyte, O., Dementyev, A., Choi, I., Follmer, S., & Schmandt, C. (2017). Exploring interactions and perceptions of kinetic wearables. *DIS '17: Proceedings of the 2017 Conference on Designing Interactive Systems*, 391–396. https://doi.org/10.1145/3064663.3064686

Kelly, N., & Gilbert, S. (2016). The WEAR Scale: Developing a measure of the social acceptability of a wearable device. *Extended abstracts: The 34th Annual CHI Conference on Human Factors in Computing Systems*, 2864–2871. https://doi.org/10.1145/2851581.2892331

Khovanskaya, V., Sengers, P., Mazmanian, M., & Darrah, C. (2017). Reworking the gaps between design and ethnography. *CHI '17: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 5373–5385. https://doi.org/10.1145/3025453.3026051

Kleinman, L., Hirsch, T., & Yurdana, M. (2015). Exploring mobile devices as personal public displays. *MobileHCI '15: Proceedings of the 17th International Conference on Human–Computer Interaction with Mobile Devices and Services*, 233–243. https://doi.org/10.1145/2785830.2785833

Koelle, M., Ali, A. E., Cobus, V., Heuten, W., & Boll, S. C. (2017). All about acceptability?: Identifying factors for the adoption of data glasses. *CHI '17: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 295–300.

Koelle, M., Ananthanarayan, S., & Boll, S. (2020). Social acceptability in HCI: A survey of methods, measures, and design strategies. *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–19. https://doi.org/10.1145/3313831.3376162

Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., & Wensveen, S. (2011). *Design research through practice: From the lab, field, and showroom*. Morgan Kaufmann / Elsevier.

Kuijer, L. (2017). Practices-oriented design. In K. Niedderer, S. Clune, & G. Ludden (Eds.), *Design for behaviour change: Theories and practices of designing of change* (pp. 116–127). Taylor and Francis. https://doi.org/10.4324/9781315576602

Kuijer, L., de Jong, A., & van Eijk, D. (2013). Practices as a unit of design: An exploration of theoretical guidelines in a study on bathing. *ACM Transactions on Computer–Human Interaction*, *20*(4). https://doi.org/10.1145/2493382

Kuijer, L., & Giaccardi, E. (2018). Co-performance: Conceptualizing the role of artificial agency in the design of everyday life. *CHI '18: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/3173574.3173699

Kuutti, K., & Bannon, L. J. (2014). The turn to practice in HCI: Towards a research agenda. *CHI '14: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 3543–3552. https://doi.org/10.1145/2556288.2557111

Kytö, M., Hirskyj-Douglas, I., & McGookin, D. (2021). From strangers to friends: Augmenting face-to-face interactions with faceted digital self-presentations. *AHs '21: Proceedings of the Augmented Humans International Conference 2021*, 192–203. https://doi.org/10.1145/3458709.3458954

Leary, M. R., & Kowalski, R. M. (1990). Impression management: A literature review and two-component model. *Psychological Bulletin*, *107*, 34–47.

Lee, Y. S. (2018). Thou and I: Exploring expressive digital interaction with interactive characteristic wigs. *TEI '18: Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction*, 581–585.

Leonardi, P. M. (2010). Digital materiality? How artifacts without matter, matter. *First Monday*, *15*(6).

Liber8tech Team. (2018, October 25). *tago arc: One E Ink bracelet with endless designs*. Indiegogo. Retrieved September 20, 2019, from http://www.indiegogo.com/projects/1116628/fblk

Lindley, J., Coulton, P., & Sturdee, M. (2017). Implications for adoption. *CHI '17: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 265–277. https://doi.org/10.1145/3025453.3025742

Lucero, A. (2015). Using affinity diagrams to evaluate interactive prototypes. *Human–computer interaction: INTERACT 2018*, 231–248.

Lucero, A., Vaajakallio, K., & Dalsgaard, P. (2012). The dialogue-labs method: Process, space and materials as structuring elements to spark dialogue in co-design events. *CoDesign*, *8*(1). https://doi.org/10.1080/15710882.2011.609888

Ludvigsen, M. (2005). Designing for social use in public places – a conceptual framework of social interaction. *Proceedings of the conference designing pleasurable products and interfaces*, 389–408.

Ludvigsen, M. (2006). Designing for social interaction: An experimental design research project. *DIS '06: Proceedings of the 6th ACM Conference on Designing Interactive Systems*, 348–349. https://doi.org/10.1145/1142405.1142459

Mackey, A. (2021, October 27). *Rethinking dynamic fabric through wearing and designing*.

Mackey, A., Wakkary, R., Hupfeld, A., & Tomico, O. (2019). Wearing digital shimmers: A fashion-centric approach to wearable technology. *Proceedings of the Conference on Research through Design*. https://doi.org/10.6084/m9.figshare.7855862.v1

Mackey, A., Wakkary, R., Wensveen, S., & Tomico, O. (2017). 'Can I wear this?' Blending clothing and digital expression by wearing dynamic fabric. *International Journal of Design*, *11*(3), 51–65. http://www.ijdesign.org/index.php/IJDesign/article/view/3177/794

Mäkelä, A., Giller, V., Tscheligi, M., & Sefelin, R. (2000). Joking, storytelling, artsharing, expressing affection: A field trial of how children and their social network communicate with digital images in leisure time. *CHI '00: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 548–555. https://doi.org/10.1145/332040.332499

Manning, P. (1992). *Erving Goffman and modern sociology*. Polity Press.

Márquez Segura, E., Fey, J., Dagan, E., Jhaveri, S. N., Pettitt, J., Flores, M., & Isbister, K. (2018). Designing future social wearables with live action role play (larp) designers. *CHI '18: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 462:1–462:14. https://doi.org/10.1145/3173574.3174036

Mathew, B., Dutt, R., Goyal, P., & Mukherjee, A. (2019). Spread of hate speech in online social media. *WebSci '19: Proceedings of the 10th ACM Conference on Web Science*, 173–182. https://doi.org/10.1145/3292522.3326034

Mauriello, M., Gubbels, M., & Froehlich, J. E. (2014). Social fabric fitness: The design and evaluation of wearable E-textile displays to support group running. *CHI '14: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2833–2842. https://doi.org/10.1145/2556288.2557299

Mayer, J. M., Hiltz, S. R., Barkhuus, L., Väänänen, K., & Jones, Q. (2016). Supporting opportunities for context-aware social matching: An experience sampling study. *CHI '16: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 2430–2441. https://doi.org/10.1145/2858036.2858175

McCarthy, J. (2002). Using public displays to create conversation opportunities. *Proceedings of Workshop on Public, Community, and Situated Displays at CSCW'02*.

McMillan, D., Brown, B., Lampinen, A., McGregor, M., Hoggan, E., & Pizza, S. (2017). Situating wearables: Smartwatch use in context. *CHI '17: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 3582–3594. https://doi.org/10.1145/3025453.3025993

Møller, T. (2018). Presenting the accessory approach: A start-up's journey towards designing an engaging fall detection device. *CHI '18: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 559:1–559:10. https://doi.org/10.1145/3173574.3174133

Nelimarkka, M. (2018). *Performative hybrid interaction: Understanding planned events across collocated and mediated interaction spheres*.

Nelimarkka, M., Jacucci, G., Salovaara, A., Dow, S., O'Hara, K., Barkhuus, L., & Fischer, J. (2018). Hybrid events: Mediating collocated participation. *CSCW '18: Companion of the 2018 ACM Conference on Computer Supported Cooperative Work and Social Computing*, 455–462. https://doi.org/10.1145/3272973.3273011

Ng, W. S. F., & Sharlin, E. (2010). Tweeting Halo: Clothing that tweets. *UIST '10: Adjunct proceedings of the 23nd Annual ACM Symposium on User Interface Software and Technology*, 447–448.

Olschewski, M., Renken, U., & Mueller, B. (2018). Collaboration technology adoption: Is it me or them? *International Journal of Technology Diffusion*, *9*(3), 13–28. https://doi.org/10.4018/IJTD.2018070102

Olsson, T., Jarusriboonchai, P., Woźniak, P., Paasovaara, S., Väänänen, K., & Lucero, A. (2020). Technologies for enhancing collocated social interaction: Review of design solutions and approaches. *Computer Supported Cooperative Work (CSCW)*, *29*, 29–83. https://doi.org/10.1007/s10606-019-09345-0

Pakanen, M., Sørensen, M.-L. S. K., Witt, F., & Eichwald, J. L. (2022). 'Ah that is cute, I will stay away!' Wearer experiences of a backpack with shape-changing accessory for keeping social distance to others in public context. *MUM '22: Proceedings of the 21st International Conference on Mobile and Ubiquitous Multimedia*, 208–217. https://doi.org/10.1145/3568444.3568445

Pan, Y., Roedl, D., Thomas, J. C., & Blevis, E. (2012). Re-conceptualizing fashion in sustainable HCI. *DIS '12: Proceedings of the Designing*

Interactive Systems Conference, 813–815. https://doi.org/10.1145/2317956.2318049

Pearson, J., Robinson, S., & Jones, M. (2015). It's about time: Smartwatches as public displays. *CHI '15: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 1257–1266. https://doi.org/10.1145/2702123.2702247

Perner-Wilson, H., Buechley, L., & Satomi, M. (2011). Handcrafting textile interfaces from a kit-of-no-parts. *TEI '11: Proceedings of the Fifth International Conference on Tangible, Embedded, and Embodied Interaction*, 61–68. https://doi.org/10.1145/1935701.1935715

Pink, S. (2009). *Doing sensory ethnography*. SAGE Publications.

Pink, S., & Morgan, J. (2013). Short-term ethnography: Intense routes to knowing. *Symbolic Interaction*, *36*(3), 351–361. https://doi.org/10.1002/symb.66

Profita, H. P., Clawson, J., Gilliland, S., Zeagler, C., Starner, T., Budd, J., & Do, E. Y.-L. (2013). Don't mind me touching my wrist: A case study of interacting with on-body technology in public. *ISWC '13: Proceedings of the 2013 International Symposium on Wearable Computers*, 89–96. https://doi.org/10.1145/2493988.2494331

Raffel, S. (2013). The everyday life of the self: Reworking early Goffman. *Journal of Classical Sociology*, *13*(1), 163–178. https://doi.org/10.1177/1468795X12474055

Rantala, I., Colley, A., & Häkkilä, J. (2018). Smart jewelry: Augmenting traditional wearable self-expression displays. *PerDis '18: Proceedings of the 7th ACM International Symposium on Pervasive Displays*. https://doi.org/10.1145/3205873.3205891

Rico, J., & Brewster, S. (2010). Usable gestures for mobile interfaces: Evaluating social acceptability. *CHI '10: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 887–896.

Rogers, Y. (2012, May 23). *HCI theory: Classical, modern, and contemporary*. https://doi.org/10.2200/S00418ED1V01Y201205HCI014

Rogers, Y., & Marshall, P. (2017, April 4). *Research in the wild*. Morgan & Claypool.

Ryan, S. E. (2014). *Garments of paradise: Wearable discourse in the digital age*. MIT Press.

Sacks, H., & Jefferson, G. (1995). *Lectures on Conversation, volumes I & II*. Blackwell.

Sadkowska, A., Wilde, D., & Fisher, T. (2015). Third age men's experience of fashion and clothing: An interpretative phenomenological analysis. *Age, Culture, Humanities*, *2*, 35–70. https://doi.org/10.7146/ageculturehumanities.v2i.130609

Salovaara, A., & Tamminen, S. (2009). Acceptance or appropriation? A design-oriented critique of technology acceptance models. In H.

Isomäki & P. Saariluoma (Eds.), *Future interaction design II* (pp. 157–173). Springer. https://doi.org/10.1007/978-1-84800-385-9_8

Sanches, P., Höök, K., Sas, C., & Ståhl, A. (2019). Ambiguity as a resource to inform proto-practices: The case of skin conductance. *ACM Transactions on Computer–Human Interaction*, *26*(4). https://doi.org/10.1145/3318143

Sanders, E. B.-N., & Stappers, P. J. (2014). Probes, toolkits and prototypes: Three approaches to making in codesigning. *CoDesign*, *10*(1), 5–14.

Sayed, I., Berzowska, J., & Skorobogatiy, M. (2010). Jacquard-woven photonic bandgap fiber displays. *Research Journal of Textile and Apparel*, *14*(4), 97–105. https://doi.org/10.1108/RJTA-14-04-2010-B011

Schatzki, T. (2016). Practice theory as flat ontology. In G. Spaargaren, D. Weenick, & M. Lamers (Eds.), *Practice theory and research: Exploring the dynamics of social life* (pp. 28–42). Routledge.

Schatzki, T. R. (2012). A primer on practices: Theory and research. In J. Higgs, R. Barnett, S. Billett, M. Hutchings, & F. Trede (Eds.), *Practice-based education: Perspectives and strategies* (pp. 13–26). Brill.

Schatzki, T. R., Knorr-Cetina, K., & von Savigny, E. (Eds.). (2001). *The practice turn in contemporary theory*. Routledge.

Schlenker, B. R. (1986). Self-identification: Toward an integration of the private and public self. In R. F. Baumeister (Ed.), *Public self and private self* (pp. 21–62). Springer. https://doi.org/10.1007/978-1-4613-9564-5_2

Schmidt, A. (2021). Die nackte weibliche Brust als Sittlichkeits- und Rechtsproblem. *djbZ*, *24*(3), 131–133. https://doi.org/10.5771/1866-377X-2021-3-131

Sengers, P., & Gaver, B. (2006). Staying open to interpretation: Engaging multiple meanings in design and evaluation. *DIS '06: Proceedings of the 6th Conference on Designing Interactive Systems*, 99–108. Retrieved October 16, 2017, from http://dl.acm.org/citation.cfm?id=1142422

Shifman, L. (2014). *Memes in digital culture*. MIT Press.

Shove, E. (Ed.). (2007). *The design of everyday life*. Berg.

Shove, E., Pantzar, M., & Watson, M. (2012). *The dynamics of social practice: Everyday life and how it changes*. SAGE Publications.

Siek, K. A., Hayes, G. R., Newman, M. W., & Tang, J. C. (2014). Field deployments: Knowing from using in context. In J. S. Olson & W. A. Kellogg (Eds.), *Ways of knowing in HCI* (pp. 119–142). Springer. https://doi.org/10.1007/978-1-4939-0378-8_6

Simmel, G. (1905). Philosophie der Mode. In *Moderne Zeitfragen* (pp. 5–41, Vol. 11). Pan-Verlag.

Simmel, G. (1908). Exkurs über den Schmuck. In *Soziologie. Untersuchungen über die Formen der Vergesellschaftung* (pp. 365–372). Duncker & Humblot.

Sinha, N., & Gupta, M. (2019). Taxonomy of wearable devices: A systematic review of literature. *International Journal of Technology Diffusion*, *10*(2). https://doi.org/10.4018/IJTD.2019040101

Skjulstad, S. (2020). Vetements, memes, and connectivity: Fashion media in the era of Instagram. *Fashion Theory*, *24*(2), 181–209. https://doi.org/10.1080/1362704X.2018.1491191

Skov, L., & Melchior, M. R. (2010). Research approaches. In J. B. Eicher & P. G. Tortora (Eds.), *Berg encyclopedia of world dress and fashion: Global perspectives* (pp. 11–16, Vol. 10). Berg. Retrieved March 1, 2023, from https://www.bloomsburyfashioncentral.com/encyclopedia-chapter?docid=b-9781847888594&tocid=b-9781847888594-EDch10003

Stappers, P. J., & Giaccardi, E. (2017). Research through design. In *The encyclopedia of human–computer interaction*. https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/research-through-design

Stigberg, S. K. (2017). A critical review on participation in mobile interaction design research. *MUM '17: Proceedings of the 16th International Conference on Mobile and Ubiquitous Multimedia*, 345–354. https://doi.org/10.1145/3152832.3156629

Suchman, L. A. (2007). *Human–machine reconfigurations: Plans and situated actions* (2nd ed.). Cambridge University Press.

Suchman, L. A. (1987). *Plans and situated actions: The problem of human–machine communication*. Cambridge University Press.

Svanaes, D., & Solheim, M. (2016). Wag your tail and flap your ears: The kinesthetic user experience of extending your body. *Extended abstracts: The 34th Annual CHI Conference on Human Factors in Computing Systems*, 3778–3779. https://doi.org/10.1145/2851581.2890268

Tamminen, S., & Holmgren, E. (2016). The anthropology of wearables: The self, the social, and the autobiographical. *Ethnographic Praxis in Industry Conference Proceedings*, *2016*(1), 154–174. https://doi.org/10.1111/1559-8918.2016.01083

Tomico, O., Hallnäs, L., Liang, R.-H., & Wensveen, S. A. G. (2017). Towards a next wave of wearable and fashionable interactions. *International Journal of Design*, *11*(3).

Tomico, O., & Wilde, D. (2016). Soft, embodied, situated & connected: Enriching interactions with soft wearables. *mUX: The Journal of Mobile User Experience*, *5*(1). https://doi.org/10.1186/s13678-016-0006-z

Toussaint, L. (2018). *Wearing technology: When fashion and technology entwine* [Doctoral dissertation, Doctoral dissertation, Radboud University].

Toussaint, L., & Toeters, M. (2020). Keeping the data within the garment: Balancing sensing and actuating in fashion technology. *DIS '20: Proceedings of the 2020 ACM Designing Interactive Systems Conference*, 2229–2238.

Turkle, S. (2012). *Alone together* (1st trade-paperback ed.). Basic Books. https://aalto.finna.fi/Record/alli.627406

Uhde, A., zum Hoff, T., & Hassenzahl, M. (2022). Obtrusive subtleness and why we should focus on meaning, not form, in social acceptability studies. *MUM '22: Proceedings of the 21st International Conference on Mobile and Ubiquitous Multimedia*, 89–99. https://doi.org/10.1145/3568444.3568457

Van Dijck, J. (2013). 'You have one identity': Performing the self on Facebook and LinkedIn. *Media, Culture & Society*, *35*(2), 199–215.

van Dongen, P. L. (2019). *A designer's material-aesthetics reflections on fashion and technology*. Retrieved October 22, 2019, from https://research.tue.nl/nl/publications/a-designers-materialaesthetics-reflections-on-fashion-and-technology(8adbdc80-7858-4b6b-a84e-62854a6f4141).html

von Terzi, P., Tretter, S., Uhde, A., Hassenzahl, M., & Diefenbach, S. (2021). Technology-mediated experiences and social context: Relevant needs in private vs. public interaction and the importance of others for positive affect. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.718315

Whitten-Woodring, J., Kleinberg, M. S., Thawnghmung, A., & Thitsar, M. T. (2020). Poison if you don't know how to use it: Facebook, democracy, and human rights in Myanmar. *The International Journal of Press/Politics*, *25*(3), 407–425. https://doi.org/10.1177/1940161220919666

Wiese, J., Kelley, P. G., Cranor, L. F., Dabbish, L., Hong, J. I., & Zimmerman, J. (2011). Are you close with me? Are you nearby?: Investigating social groups, closeness, and willingness to share. *UbiComp '11: Proceedings of the 13th International Conference on Ubiquitous Computing*, 197–206.

Wilson, E. (2003). *Adorned in dreams: Fashion and modernity*. IB Tauris.

Wong, R. Y., & Khovanskaya, V. (2018). Speculative design in HCI: From corporate imaginations to critical orientations. In M. Filimowicz & V. Tzankova (Eds.), *New directions in third wave human–computer interaction: Volume 2 – Methodologies* (pp. 175–202). Springer International Publishing. https://doi.org/10.1007/978-3-319-73374-6_10

Wong-Villacres, M., Gautam, A., Tatar, D., & DiSalvo, B. (2021). Reflections on assets-based design: A journey towards a collective of assets-

based thinkers. *Proceedings of the ACM on Human–Computer Interaction*, *5*, 401:1–401:32. https://doi.org/10.1145/3479545

Wood, J. (2022). Introduction. In *Metadesigning Designing in the Anthropocene*. Routledge.

Wulf, V., Müller, C., Pipek, V., Randall, D., Rohde, M., & Stevens, G. (2015). Practice-based computing: Empirically grounded conceptualizations derived from design case studies. In V. Wulf, K. Schmidt, & D. Randall (Eds.), *Designing socially embedded technologies in the real-world* (pp. 111–150). Springer London. https://doi.org/10.1007/978-1-4471-6720-4_7

Wynn, E. (1991). Taking practice seriously. In J. Greenbaum & M. Kyng (Eds.), *Design at work: Cooperative design of computer systems* (pp. 45–64). CRC Press.

Xiao, S., Metaxa, D., Park, J. S., Karahalios, K., & Salehi, N. (2020). Random, messy, funny, raw: Finstas as intimate reconfigurations of social media. *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/3313831.3376424

Xie, H., Mitsuhashi, K., & Torii, T. (2019). Augmenting human with a tail. *AH2019: Proceedings of the 10th Augmented Human International Conference, 2019*. https://doi.org/10.1145/3311823.3311847

Xue, H., & Desmet, P. M. A. (2019). Researcher introspection for experience-driven design research. *Design Studies*, *63*, 37–64. https://doi.org/10.1016/j.destud.2019.03.001

Yle News. (2022, December 30). *Report: Alcohol abuse a "big problem" in Finland, main cause of preventable deaths*. News. Retrieved October 9, 2023, from https://yle.fi/a/74-20010916

Zamenopoulos, T., & Alexiou, K. (2018). *Co-design as collaborative research*. Bristol University / AHRC Connected Communities Programme. Retrieved February 6, 2020, from https://oro.open.ac.uk/58301/

Zeagler, C. (2017). Where to wear it: Functional, technical, and social considerations in on-body location for wearable technology [from] 20 years of designing for wearability. *ISWC '17: Proceedings of the 2017 ACM International Symposium on Wearable Computers*, 150–157. https://doi.org/10.1145/3123021.3123042

Zimmerman, J., & Forlizzi, J. (2014). Research through Design in HCI. In J. S. Olson & W. A. Kellogg (Eds.), *Ways of knowing in HCI* (pp. 167–189). Springer. https://doi.org/10.1007/978-1-4939-0378-8_8

Over two decades ago, researchers formulated the promise that digital technologies worn on bodies will reshape our social interactions through augmenting appearance. However, to this date, such wearable technology appears mostly as health-related data tracking.
This doctoral thesis addresses this gap in adoption in everyday life, presenting studies on real-life practices of adorning with digital technology. The work investigated multiple cases using research through design in Finland, particularly the striking tradition of university students wearing and adorning boiler suits. The findings contextualise wearable technology as the practice of augmented adornment and guide adoption through dialogue-based perspectives. The approach shows routes to adoption and gives designers the tools to shape the impact of such technologies.

Aalto-DT 179/2023

ISBN 978-952-64-1495-9 (printed)
ISBN 978-952-64-1496-6 (pdf)
ISSN 1799-4934 (printed)
ISSN 1799-4942 (pdf)

Aalto University
School of Science
Department of Computer Science, Department of Design
www.aalto.fi

BUSINESS + ECONOMY

ART + DESIGN + ARCHITECTURE

SCIENCE + TECHNOLOGY

CROSSOVER

DOCTORAL THESES