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**MOBILE INTERACTION
TRAJECTORIES:
A DESIGN FOCUSED APPROACH
FOR GENERATIVE MOBILE
INTERACTION DESIGN
RESEARCH**

Michael Leitner

PhD

2015

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Michael Leitner

A thesis submitted in partial fulfilment
of the requirements of the University
of Northumbria at Newcastle for the
degree of Doctor of Philosophy

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of Arts, Design & Social Sciences

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Abstract:

Mobile HCI's (Human Computer Interaction) understanding of mobility can benefit from novel theoretical perspectives that have been largely underexploited. This thesis develops and applies a novel middle range theory *for* mobile interaction design called *mobile interaction trajectories*, demonstrating the theory's use and value in practical design settings. Mobile interaction trajectories offer a new theoretical perspective for mobile interaction design, considering people's everyday trajectories as a baseline for mediated communication, with foci on practices and experiences of changing states of connectedness, chronologies of mediated communication, and mobile communication routines. Following a research through design methodology, *probing* was used as a creative research method. Two probing experiments informed the theory's development. A new Probe resource was designed and applied, called the Hankie Probe. It was used to collect instances of mobile interaction trajectories and informed a range of design workshops. The Hankie Probe is based on a fabric-based format and expresses everyday trajectories, and mobile communication practice and experience via stitched and drawn handmade space-time diaries. Research *about* design analysed the design processes with the completed Probes revealing the middle range theory's value. The theory's distinctive characteristics have shown to inform generative design processes. The trajectory-based perspective inspired design concepts for contextually adaptive services that enable new communication experiences and alter the chronology of social interaction. The thesis contributes to knowledge by underpinning generative design work with novel mobility theories via a new Probe format for mobile interaction design research. The following additional discoveries were made: There are three basic probing functions in generative design workshops; designer's experiences and subjective interpretation augment insights about users and contexts in design workshops, the fabric-based handmade Probes influenced design work offering a captivating authentic format that requires subjective interpretation.

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Authorship Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Faculty Ethics Committee.

Dates:

20th of January 2011 - Ethical approval for pre-studies, for data collection and data use in design workshops.

15th of November 2011 - Ethical approval for data collection for probing experiment one.

03rd of May 2012 - Ethical project approval for design workshops.

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I declare that the Word Count of this Thesis is 76.614 words

Name: Michael Leitner

Date and Signature

Publications:

At the time of this thesis document's publication, parts of the research have been published already. The following research papers document pre-studies conducted in the early stages of research. Main results/findings have not been published yet.

Leitner M, Cockton G, Yee J S R, Greenough T, (2012), The hankie probe: a materialistic approach to mobile UX research, in Proceedings of the 2012 ACM annual conference extended abstracts on Human Factors in Computing Systems Extended Abstracts, ACM, New York, NY, USA, pp. 1919-1924

Leitner, M (2012) Supporting design for mobile people: a material-istic approach; in Proceedings of the 2012 ACM annual conference extended abstracts on Human Factors in Computing Systems Extended Abstracts, ACM, New York, NY, USA, pp. 935—938

Leitner, M.; Cockton, G; Yee J S R (2013), Making short films to make sense for mobile interaction design, in Proceedings of the 15th international conference on Human computer interaction with mobile devices and services, ACM, New York, NY, USA, pp. 304—307

Leitner M.; Innella, G.; Yauner F. (2013), Different Perceptions of the Design Process in the Context of Designart, in Journal of Design Studies; Volume 34, Issue 4, pp. 494—513

Chapter 1: Introduction

This chapter provides a contextual overview of the motivations, background and methodology of this thesis as well as a concise overview of its contributions to knowledge.

1.1 Motivation and research aim

The primary aim of this thesis is to explore and evaluate aspects of novel mobility theories for the purpose of generative design processes¹. This thesis' approach is research *for* design. In particular it is *for* design researchers, who inform and support design processes by offering designers insights about users and contexts. For this audience, the thesis presents new insights into the value of inspiring and informing mobile interaction design processes. The thesis presents a new middle range theory² for mobile interaction design, called *mobile interaction trajectories*, which offers a new theoretical perspective for understanding, framing and scoping insights about users and contexts for mobile interaction design. The thesis research develops and applies mobile interaction trajectories, and then evaluates the theory's value for generative mobile interaction design processes.

The middle range theory was developed using a research *through* design approach. However, I did not act as a designer producing design concepts and prototypes myself – normally a typical characteristic of research through design (Gaver, 2012; Zimmerman, 2007). Rather, I worked with mobile interaction trajectories acting as a *design researcher* informing and supporting design teams' work via novel design resources³. I designed a Probe and used it to collect instances of mobile interaction trajectories in collaboration with Probe respondents. The completed Probes were curated and presented to several design teams,

¹ A design process aiming to generate and innovate new product and service opportunities inspired and informed by insights about users and contexts.

² A middle range theory *for* design allows for the conceptualisation and framing of problems and insights for design, in a way that could not be done with holistic, overly general and abstract theories, or with overly specific design solutions or theories. In other words, a middle range theory for design aims for a (re)usable perspective to frame, scope and focus insights about users and contexts for design processes. Chapters 2 and 3 elaborate on this initial definition.

³ In this thesis *design resources* are understood as research artefacts such as Probes, Personas, Scenario storyboards (etc.) that are used to support and inform design processes by collecting and/or communicating insights about users and contexts in a design setting. A design resource is a designed artefact in itself and uses a particular design for collecting and expressing insights. The term and its understanding is inspired by Cockton's Working to Choose Framework (W2C) (Cockton, 2012, 2013).

asking them to respond with innovative design concepts. During the later stages of thesis research, I exploited a research *about* design approach to analyse and evaluate design teams' work with mobile interaction trajectories in this practice-led design setting. This qualitative analysis of design teams' processes revealed the middle range theory' value for generative design processes.

The remainder of this section will describe the above in more detail.

New thinking in mobility research: The notion of what mobility is, or what it means to be mobile has dramatically changed over the course of the last decades. Hence, both what it means to be mobile, and also mobile interaction design's notion of mobility along with mobile interaction need to be reconsidered. In the past, 'mobility' was used as a synonym for corporeal movement of people and of *being transported*. However, new theoretical developments in sociology (Urry, 2007), social-geography (Schwanen and Kwan, 2008; Green, 2002) and media studies (Meyrowitz J., 2005) open up new opportunities for user and context focused mobile interaction design research, as explored in the thesis research reported here. One central claim of these *novel mobility theories* is that people are less dependent on locations. Communication media allows us to connect to each other *whenever* we want, without the necessity of physical closeness or corporeal movement. Research has introduced the notion of *fluid interaction* (Bell and Dourish, 2011; Kakihara and Sorensen, 2002), which describes social interaction as not being characterised by regions, but rather as a dynamic process over time, in which boundaries and connections can come and go fluxionally.

Research within the HCI⁴ (Human Computer Interaction) and interaction design community has raised the issue of using novel mobility theories for design purposes. Theoretical perspectives, such as *fluid interaction* (Kakihara and Sorensen, 2002; Bell and Dourish, 2011), *mobility as involvement* (Fallman, 2003), *screen mobility* (Juhlin et al, 2013) and *anchored mobilities* (Williams, et al. 2008), offer new ways to understand multi-layered mobility issues for interaction design. However, considering the large amount of research on mobile devices, there has been little response to these new these theoretical possibilities in mobile

⁴ HCI – Human Computer Interaction is referred to as a field of research or as a community of researchers dedicated to the study of human-computer interfaces and the use of information and communication technology. Over the past years the terms interaction design and interaction design research have been used more prominently, foregrounding the change of attitude and focus of work in this field, which now embraces design work as a means for research, focusing on the design of interactive technologies, rather than the study of such. This shift of attitude is also documented in the literature, e.g. Rodgers, 2004; Rodgers et al. 2011.

interaction design research. Recent critiques reveal a rather traditional understanding of mobility within HCI and interaction design research, according to which mobile interaction design retains a predominant focus on *portable devices* and on *locations* (Fallmann, 2005; Jumisko-Pyykkö and Vainio, 2010)⁵.

The thesis addresses the following research problem: (Mobile) HCI and interaction design needs to reconsider what “mobile interaction” means. Interaction design research has proposed new theoretical perspectives that are inspired by novel mobility theories. However, (mobile) HCI and interaction design can benefit from more research in this area. To address this problem, the thesis proposes, applies and evaluates a middle range theory called *mobile interaction trajectories*. The theory belongs to the group of existing theoretical perspectives, such as *fluid interaction* (Kakihara and Sorensen, 2002; Bell and Dourish, 2011) and *mobility as involvement* (Fallman, 2003). The theory’s principles are introduced in the following paragraph⁶:

Mobile interaction trajectories: This middle range theory highlights *mobile social interaction*, supporting generative design work that focuses at people’s new practices and experiences when staying in touch. The theory considers one central device user, who is connected to one or various others via communication technologies and has two distinctive characteristics.

First, it aims to enhance the notion of *mobile context* not being a particular geographical space, e.g. the urban area. Rather than focusing on such pre-defined locations, the theory focuses on people’s everyday *trajectories* (see Figure 1.1). Trajectories are understood as people’s everyday journeys that traverse several places of everyday life, such as routes from home to work and back. In this respect, the middle-range theory is inspired by Benford et al.’s (2009) *interaction trajectories*, exploiting some of its facets for the context of social mobile interaction in everyday life. This changes the theoretical perspective for mobile interaction design. *Mobile context* is not a (single) location, but takes place alongside people’s everyday trajectories, and therefore across a set of interlinked places of everyday life.

Second, the middle range theory looks at how mediated mobile communication

⁵ An extreme interpretation of these predominant foci would mean that mobile interaction design is understood as designing interactions between users and devices that are typically taking place in locations associated with physical mobility, such as areas of transit, or urban areas – location that are often called mobile contexts.

⁶ Chapter 3 provides an extended discussion on the theory of mobile interaction trajectories.

unfolds over time and rooted in everyday trajectories. This aims to ground the notion of *fluid interaction* in the context of everyday life. The theory captures how people have developed particular mobile interaction practices to maintain and manage their mediated communication as part of their everyday trajectories. Thus, it expects people to maintain multiple connections to distant others for certain moments/periods of connectedness, forming into *changing states of connectedness, chronologies of mediated communication and mobile communication routines*⁷.

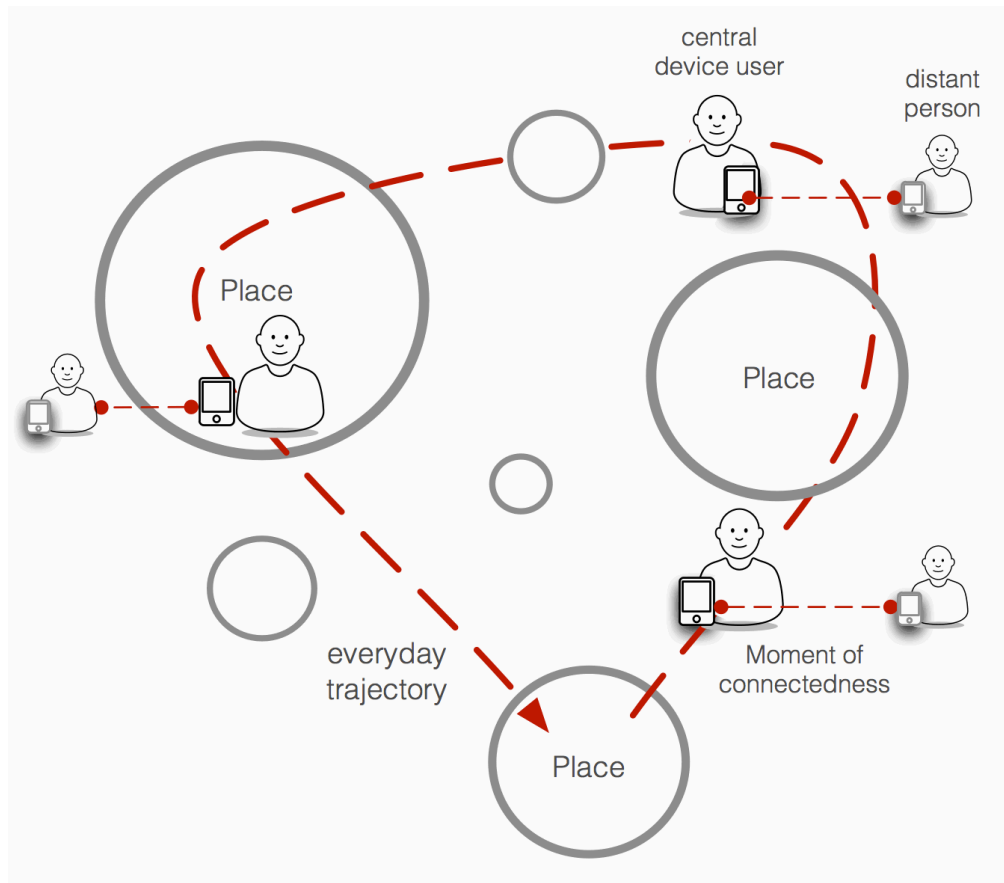


Figure 1.1: Mobile interaction trajectories: Device users are on their individual everyday trajectories crossing several places of everyday life. This middle range theory captures how during their everyday trajectories, device users have several **periods/moments of connectedness** over the course of a day. People have particular practices and experiences in interacting with distant others during their individual trajectories.

⁷ Mobile communication routines are understood as reoccurring structures of communication, such as regular phone calls to a specific person at a similar time and from a similar place. For example, a person's daily phone call during the homeward trip from work, informing his or her partner that s/he is coming home.

1.2 Methodology and stages of research

The thesis research followed a research *through/about* design approach with three stages. The first stage reviewed novel mobility theories and potential research approaches. Insights gained here informed the second stage, when the thesis' two main probing experiments⁸ were conducted (research *through* design). The third stage looked back at the practice-led research experiments of stage two, resulting in an evidence-based analysis of mobile interaction trajectories' value for generative design processes (research *about* design). Here, the three stages are discussed in more detail:

The **first stage** comprised a number of explorative pre-studies. I developed the basis for the middle range theory of mobile interaction trajectories and experimented with different approaches to research into mobile interaction practice and experience. In particular, I started to experiment with fabric-based Probe formats that can be completed by hand⁹ using practices such as stitching, embroidery and doodling. Insights from this first stage informed the design of the two main probing experiments during stage two.

The **second stage** was characterised by practice-led design research (research *through* design). I chose probing as a research approach. Probing is understood as a contemporary user and context focused design research approach that uses Probe¹⁰ packages for gathering insights in collaboration with Probe respondents. Insights about users and contexts are consequently used to inform and inspire design processes for innovative novel products and services. This approach was chosen for three reasons:

- The design of the Probe resources was a promising way of developing and grounding the middle range theory for practical design settings.

⁸ The term *experiment* is inspired by Binder and Redström's (2006) 'programme and experiments' approach to document research through design. They use the term *experiment* to refer to research-centred design activities and design studies. In this thesis, a *probing experiment* starts with the design of a Probe and ends with an articulated design concept. The probing experiments conducted for this thesis research were structured into four phases, (1) Probe design, (2) insights collection in collaboration with Probe respondents, (3) Probe curation by the thesis researcher and (4) design teams' work with the curated Probes. These phases will be further elaborated in *Chapter 4 Methodology*.

⁹ In the following, this aspect of the Probe will be referred to as "*handmade*". A further definition is provided later in this chapter, as well as in Chapter 5.

¹⁰ A Probe is understood as one or more user and context focused design resources used for gathering and expressing informative and inspirational insights about users and contexts in design settings. It is a designed artefact in itself, aiming to evocatively and creatively engage participants in open subjective self-reporting activities, in a format and media that fits the design setting(s).

- Probes were a means to *materialise* the middle range theory. In particular, designed Probes allowed disseminating theory via user and context focused design resources. It allowed collecting and communicating insights about users and contexts that express instances of mobile interaction trajectories.
- Analysing design processes using theoretically framed Probes offered a way of researching the middle range theory's value for generative design processes.

I conducted two *probing experiments* through which I researched the middle range theory's value for generative design processes. I designed a user and context focused design resource called *the Hankie Probe*¹¹ (Figure 1.2 and Figure 1.4), based on the theory of mobile interaction trajectories. I called it the *Hankie Probe*, as it is based on a fabric format that is similar to a handkerchief. The Hankie Probe supports the creation of artful space-time diaries that show people's everyday trajectories and also, when and where and in which contexts they use their mobile devices to communicate. The Probe asks respondents to make notes about their context of mediated communication during their everyday trajectories.

Furthermore, it could expose their moments/periods of connectedness, their changing states of connectedness, chronologies of mediated communication and mobile communication routines as part of their everyday journeys. The completed Probes and insights collected in the debriefing interviews were analysed, curated and used in a number of design workshops.

The fabric-based Probes' format is understood as allowing Probe respondents to create individual *handmade* artefacts that express space-time diaries in visually attractive and personalised ways. The Probes' completion includes materials and practices such as fabric, embroidery, sewing, stitching and drawing. The Probes' fabric format enables such practices. A Probe that has been completed using such

¹¹ The Hankie Probe is considered to be a Probe for the following reasons: First, it is a particularly designed artefact for gathering and expressing insights about users and contexts in design settings. Second, it aims to evocatively and creatively engage participants in open and subjective self-reporting activities, to an extent and in a format and media that fits the design setting(s). Third, its focus lies on evoking open and subjective instances of mobile interaction trajectories, offering informative and inspirational insights for design workshops. The Hankie Probe is considered to be part of the family of (HCI) Probes, but with essential differences in its use/application, compared to the original 'Cultural Probes' presented by Gaver et al. (1999). The Hankie Probe's use in this thesis research can be compared to *Informational Probes* (Crabtree et al. (2003), to Mattelmäki's (2007) work on *Design probes*, but also to Visser's (2011) work on *Context mapping*. A further reflection is presented in Section 5.3.2.

practices is understood as a *handmade Probe*¹². The Hankie Probes do not make use of commodities like disposable cameras or sketchbooks. Their materials and practices opened up alternative ways to complete Probes that offer creative ways of expression, with the completed Probes showing personal and individual marks.

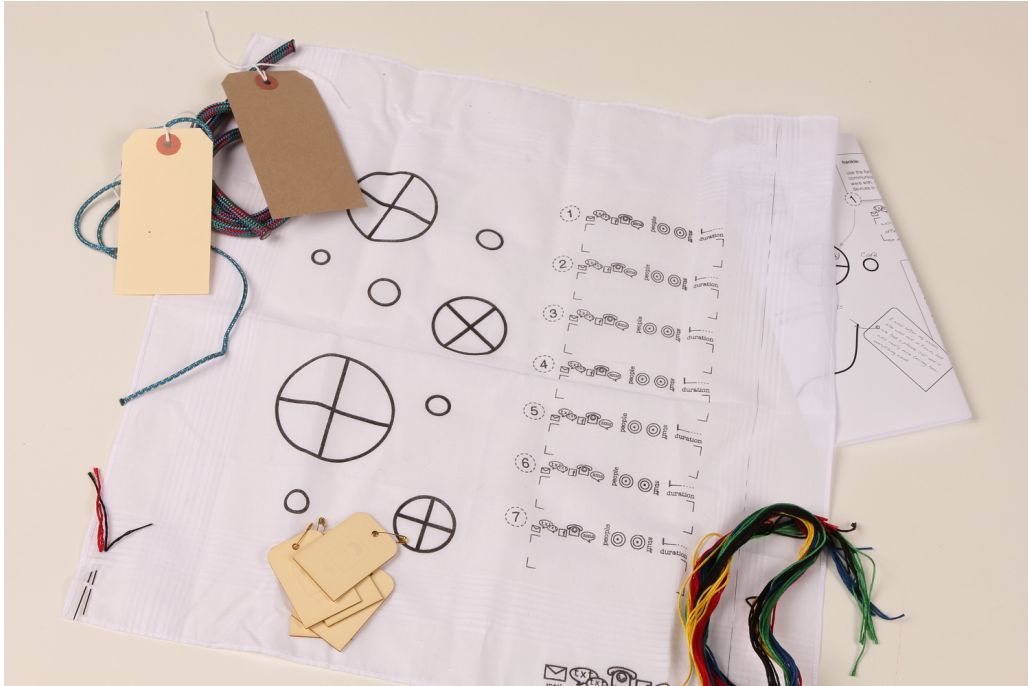


Figure 1.2: The Hankie Probe for probing experiment one: Mobile relationships. The main entity is the fabric cloth in form of a handkerchief. The circles printed onto the cloth represent places. Respondents are asked to record their daily trajectories by stitching or drawing them on the space-time diary. By connecting the circles (places) they create their own everyday space-time diary. Participants are also asked to take notes about their device use. They indicate the places of communication on the space-time diary and take notes about the context of these situations. The forms on the right side of the hankie space allow Probe respondents to do so.

The scope of this thesis research is the early front end of design. The practice-led design research during stage 2 considered a (hypothetical) situation within a research innovation project at a research centre or at a company. The aim of this hypothetical project was to innovate design concepts for new services in response to a society increasingly mobilised by new communication technologies. The project looked for new concepts for social mobile communication in everyday life.

¹² Clearly, other Probe completion practices, such as writing, doodling, or even manipulating a disposable camera (etc.) require the use of hands too. The Hankie Probe shares this characteristics with existing Probe designs, e.g. presented by Mattelmäki (2006) and Wallace et al. (2012). However, in this thesis, the term *handmade* is used for referring to practices for manipulating the Probes' fabric format, such as stitching, embroidery and doodling on the fabric. Further, the term *handmade* aims to describe completed Probes that show individual styles and marks of completion that result from the Probes' fabric format and related practices. The term *handmade* is chosen over the term *craft* since the Probe respondents do not require a special skill set or training for Probe completion using these practices.

Probing experiment one worked on design concepts for young couples' everyday communication. The second probing experiment looked at mobile work communication. Both application domains provided a challenging context for researching the value of mobile interaction trajectories.

In this hypothetical situation, I acted as a design researcher, whose task it was to gather user-centred insights and to collaborate with design teams. This setup allowed me to carry out and facilitate realistic design activities, similar to a 'real project'. The hypothetical situation however, left enough freedom to explore new theoretical perspectives and alternative Probe formats. It also allowed me to analyse the design process and resulting design concepts empirically.

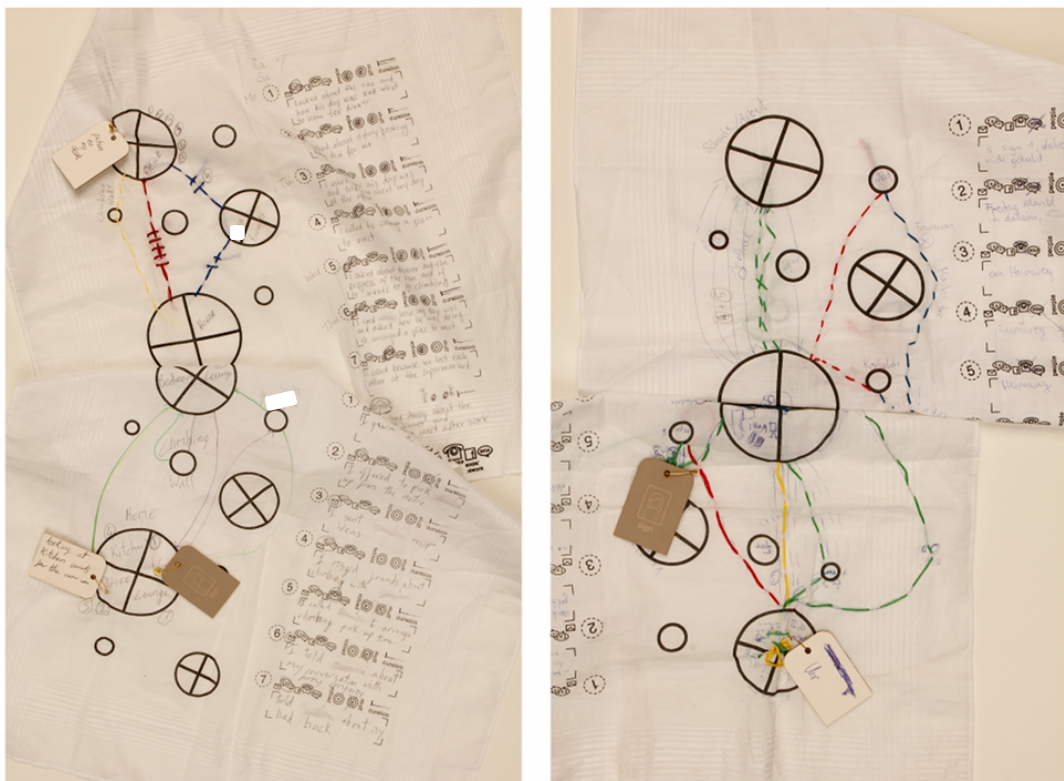


Figure 1.3: Two examples of completed space-time diaries showing everyday trajectories. The completed Probes were used in debriefing interviews with Probe respondents to elicit experience accounts. The completed Probes were description, and an annotated space-time diary highlighting the scenario's relevant aspects.

In each of the two probing experiments during stage 2 I gathered insights with 5 Probe respondents. I *curated* and prepared the completed Hankie Probes (see

Figure 1.3 and Figure 1.5) for design workshops¹³. Probe *curation* meant selecting relevant themes and quotes from the debriefing interviews, visually annotating the completed space-time diaries for better comprehension and providing a short Persona description. These curated Hankie Probes are understood as *instances of mobile interaction trajectories*, which introduce theoretically framed examples of mobile interaction trajectories to design teams. The curated Probes were used in design workshops with 2 to 5 designers (8 design workshops with 28 designers in total). Both main probing experiments used a similar Probe concept to collect and communicate insights about users and contexts.



Figure 1.4: The Hankie Probe for probing experiment two: Mobile work communication. The raw Probe shows the space-time diary printed onto a fabric cloth. Respondent's sewed, stitched and drew their trajectories onto the space-time diary connecting circles (places) – as in experiment one. The Probe participants were asked to take notes about the contexts in which they use their mobile phones for work communication.

¹³ In this thesis a design workshop is understood as a design session with designers meeting and working together. It does not refer to a particular room or workspace offering specific tools or resources for design work.



Figure 1.5: Two examples of completed space-time diaries. The completed Probes were used in debriefing interviews with Probe accounts. The completed Probes were curated and presented with supplementary materials, e.g. quotes, annotations, etc. as in probing experiment one.

Design workshops gathered data on design teams' work with the curated Probes that could expose mobile interaction trajectories' value for generative design processes. This analysis of the design processes was done at stage 3 of the thesis research (research *about* design). However, before summarising stage 3, two further aspects are discussed.

Using probing to research novel mobility theories, two important aspects emerged: First, *the characteristics of the design process with the curated Hankie Probes* and second *the influences of the Probes' fabric-based format* on the design process. Both aspects appeared to influence design teams' creative processes, as revealed by analysis of the design processes and resulting design concepts.

The characteristics of the design process with the curated Hankie Probes and other influences on design teams' process: Probing is now widely used for interaction design and HCI research. Its broad application has led to a discussion about its aims, its philosophy and its value, especially in comparison with historically important approaches within HCI, such as ethnography. Interestingly, and most probably due to HCI's focus on *understanding users*, probing has mostly

been perceived as an alternative way of gathering insights about users and their contexts. However, seeing probing as a *design approach* that supports designers in making design choices has been emphasised and explicitly discussed less.

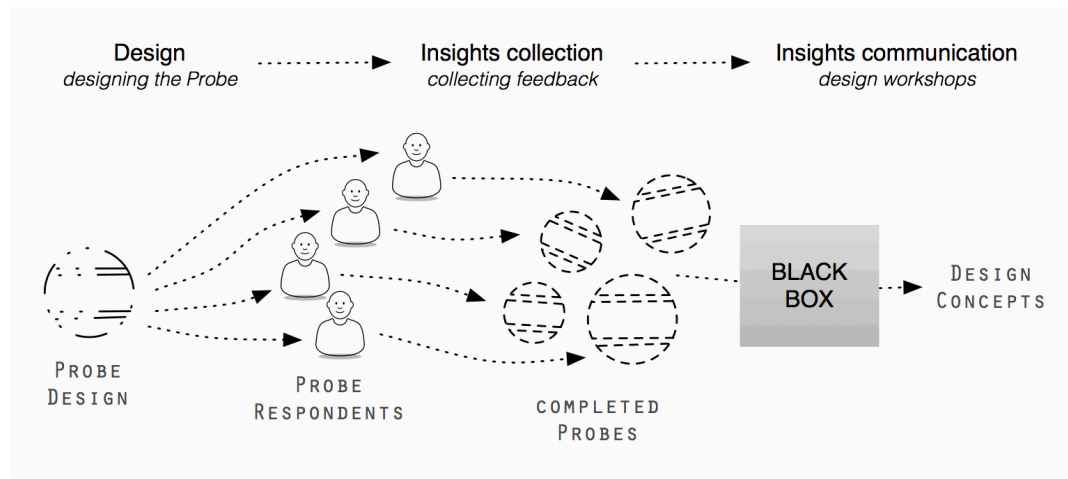


Figure 1.6: Design work with Probes is perceived as a black box. It has not been discussed, analysed and theorised at a detailed level.

Even so, *probing* has been researched and its value is partly known. The approach has been shown to inform and inspire designers, engender empathy, and enable dialogue between users and designers, and within design teams (Mattelmäki, 2006). However, what is missing is an analysis of the Probes' functions during the design process, which reveals how designers deal with insights about users and contexts introduced to them via the completed Probes. Within current HCI research, the design process following completion of Probes has hardly been discussed, analysed and theorised. Rather, it is seen as a *black box* (see Figure 1.5). Therefore, the secondary aim of this thesis was to analyse the design teams' processes with instances of mobile interaction trajectories. In doing so, I re-positioned probing closer to more traditional design practices such as design sketching. I drew from theories framing design processes from a *pragmatic and reflective* point of view (Lawson, 2006; Cross, 2006).

The influence of the Probes' handmade fabric-based format: The thesis research also needed to study Probes as designed artefacts, understanding the influence of the fabric-based Probe format that I chose to work with. The move towards fabric-based Probes introduced another activity to the thesis research: the actual design of Probe artefacts and its influence on the design processes with mobile interaction trajectories. The research reported in the thesis analysed how it influenced the design teams' work.

A broader discussion of bespoke materials and formats for designing Probes and their influences on the design process is lacking in HCI. Mattelmäki (2007) and Visser (2009) discussed the design of *design communication*¹⁴, highlighting the value of unprocessed materials that designers thrive on and that elicit visual narratives and shared understandings. However, textbooks tend to present Probes (the Probe package itself) as a standardised instrument, e.g. Hannington's 'Universal methods of design' (2012). Probes are often seen and used in the format of the original Probe package that was introduced by Gaver et al. (1999), including disposable cameras, diaries, postcards and maps. Interaction design can benefit from a broader discussion of different Probe formats. The value of fabric-based handmade Probes for design communication has not been researched yet to identify their influence on design teams' processes.

Together with the primary research aim of researching mobile interaction trajectories' value for generative design processes, the two secondary research aims are addressed during analysis in stage 3 of this thesis research.

The thesis' **third stage** was *research about design*. It was a reflective phase that analysed the design teams' processes from stage 2. Applying a mixed method qualitative approach, I conducted three *design studies* analysing the design teams' work during the two main probing experiments: their design concepts, transcripts and protocols of their design process, and also post-design debriefing interviews with them. The following three analytical foci were applied, relating to the primary and the two secondary research aims:

- *Primary research strand: The value of mobile interaction trajectories for generative design processes:* The analysis looked at the design teams' work identifying *mobile interaction trajectories' aspects* that informed and inspired the generative design processes. Furthermore, it analysed the resulting design concepts' characteristics. The results expose mobile interaction trajectories' value for informing and inspiring generative design.
- *Secondary research strand (a): The characteristics of the design process with the curated Hankie Probes and other influences on design teams' processes:* I analysed the design teams' processes, showing its characteristics as well as

¹⁴ In this thesis, the term describes the communication of insights about users and contexts to or in design settings with (or without) design resources.

identifying other influences that informed their creative work. The results help interpreting the primary results about mobile interaction trajectories. As a secondary outcome, the thesis contributes to knowledge in an area that has so far understood design processes with Probes as 'black art' (Bohner et al. 2007).

- *Secondary research strand (b): The value of fabric-based handmade Probes in design workshops:* I analysed the design workshops with the curated Hankie Probes with a particular focus on the perception and use of the handmade space-time diaries. The analysis revealed how this Probe format affected design work with mobile interaction trajectories. As a secondary outcome these findings contribute to knowledge of design communication and the design of Probes.

1.3 Documenting the research's progress

The research applied Binder and Redstöm's (2006) *programme and experiments* approach to document and structure the thesis research. The *programme* is a set of programmatic statements that describes the knowledge regime¹⁵, which summarises a researcher's changing understanding of a research topic over time. The programme acted as a frame of reference that guided the research. Binder and Redström (2006) describe *experiments* as research and design studies that investigate and evolve the programme. Thus, each pre-study and probing experiment in this thesis research is understood as such an *experiment*. Conducting and analysing experiments and their outcomes evolve and change the programme.

The programme for this research evolved around a main and two secondary research strands, each relating to the primary and secondary research aims: (1) the value of mobile interaction trajectories for generative design purposes, (2a) the characteristics of the design process with the curated Hankie Probes and other influences on the design teams' work, and (2b) the value of fabric-based handmade Probes in design workshops. The evolution of these research strands is documented by three programme versions, each of which is related to a stage of research (See Figure 1.7). The programme versions are documented in *Chapter 4*.

¹⁵ The term *knowledge regime* is used by Binder and Redström. It describes the current state of 'what is known' about the research topic. It is understood as a provisional body of knowledge that frames the research inquiry and keeps evolving. The programmatic statements are presented in *Chapter 4 Methodology*.

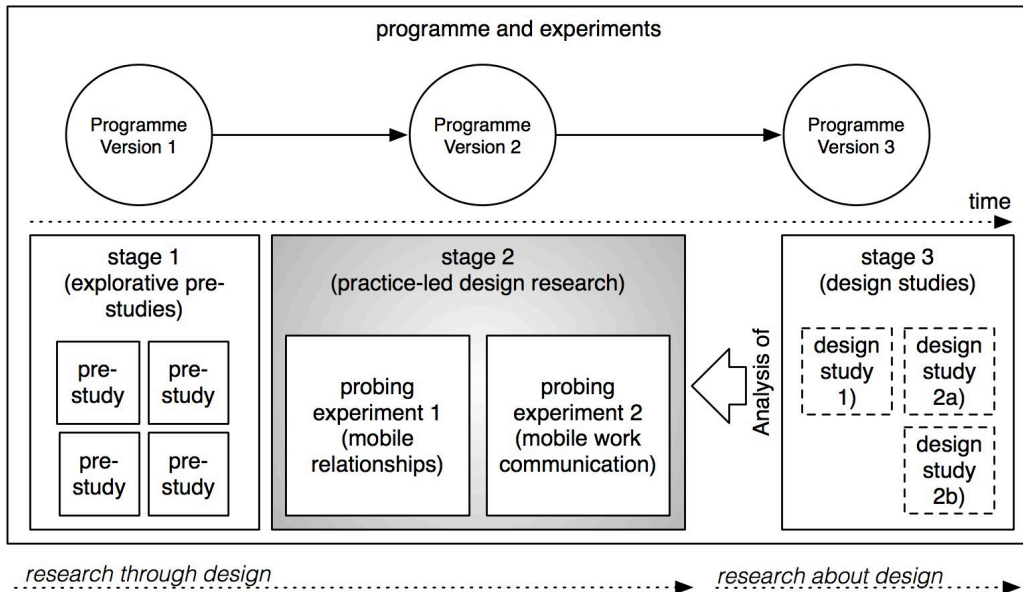


Figure 1.7: Research methodology: Three stages of research. Three programme versions describe the evolution of the understanding of the thesis' three research strands.

1.4 Outcome and Contribution to Knowledge

The audience of this thesis are *design researchers*, who support and inform designers' generative design processes. The thesis' contribution is twofold and is summarised in Table 1.1..

First, the thesis contributes a new theoretical perspective of novel mobility theories for understanding users and contexts for mobile interaction design and mobile HCI research. The result is a middle range theory for mobile interaction design, called *mobile interaction trajectories*. The thesis demonstrates one way of embedding this middle range theory in practical design settings *via a design resource portfolio*, and through this, identifies the theory's value for generative design processes. These results are presented in Chapters 3, 5 and 6.

Second, the thesis proposes an alternative interpretation of the design processes with Probes, positioning *probing* closer to practices like design sketching (rather than to e.g., Ethnography). This introduces a detailed focus on design process with Probes that has not previously been attempted. The research identifies three Probe functions in design processes. This is a contribution to knowledge from a design theory point of view. These results are presented in Chapter 7.

Third, the value of fabric-based handmade Probes for *design communication* has not yet been researched. Thus, another contribution to knowledge is the analysis of fabric-based handmade Probes in design workshops. The thesis presents this format's influence on design work and contributes to literature about the design of Probes and to the area of design communication. These results are presented in Chapter 8.

1.5 Structure of this document:

The thesis is structured in three parts. The first part presents the Contextual literature review (Chapter 2) and the middle range theory of mobile interaction trajectories (Chapter 3), as well as the thesis' methodology (Chapter 4). The second part (Chapter 5) presents the collected instances of mobile interaction trajectories as a design resource portfolio of completed and curated Hankie Probes. Chapter 6 presents an analysis of the design teams' processes with these instances of mobile interaction trajectories in terms of the theory's value in generative design processes. The third part (Chapter 7 and 8) presents the two secondary research strands, providing a broader context for interpreting the main results. The following overview presents more details of each chapter:

Chapter 2 is a contextual review that looks at prominent theoretical perspectives in contemporary mobile interaction design, including existing uses of novel mobility theories within HCI research. It reviews approaches that are used to inform and inspire design work in this area. The chapter explains the relevance of this thesis to contemporary mobile interaction design. Chapter 2 also reviews theories of design processes, with a closer look at generative design processes. It finishes with a review of the state of the art in probing and Probe design.

Chapter 3 presents the middle range theory of mobile interaction trajectories. It discusses the theory's aspects and relates it to literature from interaction design, sociology, media studies and social-geography. The chapter builds the theoretical basis for the design of the Hankie Probes.

State of the Art / Gap	Thesis Aim	Outcome	Contribution to knowledge
Primary:			
New theoretical perspectives on mobility remain underexploited for generative design research.	Articulate a new perspective of novel mobility theories for the purpose of generative design research.	A middle range theory for mobile interaction design called <i>mobile interaction trajectories</i> .	Contributes knowledge to the area of generative mobile interaction design research.
	Present a user and context focused design resource portfolio expressing real-life examples of the new middle range theory.	<i>Instances of mobile interaction trajectories:</i> completed and curated Hankie Probes from two probing experiments.	
	Evaluate the middle range theory's value for inspiring and informing generative design processes in practical design settings.	An analysis of <i>mobile interaction trajectories'</i> value for informing and inspiring generative design processes.	
Secondary			
The design process with Probes is understood as a <i>black box</i> .	Research the characteristics of the design process with the curated Hankie Probes and identify other influences on the design teams' processes.	Identification of the characteristics of the design processes with curated Hankie Probes and other influences informing design teams' work.	Contributes to knowledge about design processes with Probes.
The value of fabric-based handmade Probes for design communication has not been researched yet.	Research the qualities of fabric-based handmade Probes in generative design workshops.	Identification of the fabric-based handmade formats' influence on design processes with mobile interaction trajectories.	Contributes to knowledge about design communication.

Table 1.1: A Summary of the thesis primary and secondary aims and outcomes.

Chapter 4 describes the research methodology of this thesis as well as the programme and the experiments that were conducted over the course of the three stages of the research. It explains the stages of research and previews the evolution and development of the middle range theory over the course of the thesis research. The core element of this chapter is the description of the two main probing experiments. It includes an overview of Probe participants and design teams who worked with the curated Hankie Probes in the two experiments.

Chapter 5 and 6 present the thesis' main outcomes. Chapter 5 then presents the *design resource portfolio*. It presents the completed and curated Hankie Probes from the two main probing experiments. They are presented as *instances of mobile interaction trajectories* representing the middle range theory through real life examples. The chapter discusses the background of the Probe design as well as the completed Probes' scope and content.

Chapter 6 is an analysis of the design teams' work with the curated Hankie Probes. The chapter exposes the value of mobile interaction trajectories for generative design processes. The analysis draws from three sources: from the design concepts that resulted of the design teams' work, from an analysis of the design processes with the curated Hankie Probes, and from post-design debriefing interviews with design teams. Chapter 6 reveals the aspects of mobile interaction trajectories that informed and inspired the designers' processes.

Chapters 7 and 8 provide a broader context for interpreting findings presented in Chapter 6. Chapter 7 is an analysis of the design processes' characteristics and contextual influences on the design teams' processes with the curated Hankie Probes. Chapter 8 presents an analysis of the influence of fabric-based handmade Hankie Probes in design workshops. This analysis shows how the designers perceived and worked with the handmade Probes. This format's influence on the work with mobile interaction trajectories is analysed. The format's value for design communication is also discussed.

Chapter 9 summarises the thesis' primary and secondary outcomes. It restates the thesis' contribution to knowledge, reflects on the research methodology, and discusses this research's limitations and future work.

This first chapter introduced the thesis' research context, aims and outcomes. Before presenting mobile interaction trajectories and the methodology, the next chapter will review the research's thematic context more thoroughly.

Chapter 2: Contextual literature review

This contextual literature review is split into two parts, and in line with the thesis' programmatic research strands. The first part is dedicated to the primary research strand: *New mobility theories for generative design purposes*. The second part of this chapter refers to the two secondary research strands: *2a) the characteristics of the design process with the curated Hankie Probes* and *2b) the value of fabric-based handmade Probes in design workshops*.

Primary research strand: This part will discuss theory's role for framing and conceptualising (insights about) users and contexts for interaction design. Based on this understanding, the section will review prominent and new theoretical perspectives on insights about users and contexts for mobile interaction design. The aim is not to discuss the results and findings of studies *about* mobile device use (or similar). Instead, the aim is to show the theoretical perspective underpinning such studies that aim to support and inform mobile interaction design. This reveals the theoretical perspectives design researchers talk about when they discuss about *mobile context* and *mobile interaction design*.

Further, this part of the literature review will discuss three examples of research approaches used to inform and inspire mobile interaction design processes.

Discussing these examples the literature review emphasise two aspects:

- First, it shows that each approach to inform and inspire design relies on a *theoretical perspective* for framing insights about users and contexts (implicitly or explicitly).
- Second, it shows that approaches make use of user and context focused design resources, which are *designed artefacts* determining how insights are communicated to design settings.¹⁶

Reviewing the three selected approaches exposes their theoretical perspective as well as the design resource formats that are used for insights collection and communication.

¹⁶ The design of resources, such as Probes (or similar), also determines how insights are *collected*. However, this thesis research is primarily focusing on the value of design resource formats for *communicating* insights.

Secondary research strands: The second part of the literature review discusses what is known about generative design processes with Probes. This creates the basis for the thesis' second research strand 2a): *Characteristics of the design process with the curated Hankie Probes*. It looks at theories of the design process, bringing three philosophical positions to the fore. Furthermore, the section discusses generative design processes through a pragmatic account describing design processes as situated reflective practice, positioning design work with Probes in this theoretical context. The second part of the literature review also relates to the thesis' research strand 2b) *The value of fabric-based handmade Probes in design workshops*. These sections discuss what is known about the design of Probes and the function of particular Probe formats for insights communication in design settings. Identifying a lack of knowledge in this area, the section emphasises the necessity for researching Probes' value in this respect. The review finishes with a discussion on the potential value of fabric-based handmade Probe formats for the purpose of design communication.

2.1 Primary research strand

This section introduces theory's role for interaction design for framing, scoping, and focusing insights about users and contexts for mobile interaction design processes. On the basis of this understanding, this section introduces four prominent theoretical perspectives on users and contexts within mobile interaction design. Finally, the section discusses three exemplary approaches for user and context focused mobile interaction design research.

2.1.1 Theoretical perspectives on users and contexts

Theories describe (a model of) reality, containing descriptive and explicatory (causal) statements that allow making predictions, and which can be empirically tested. It describes how 'something' is working by showing its elements in relationship to one another (Friedman, 2003)¹⁷. Theories are a relevant for interaction design, as they influence the understanding of problem spaces. Theories *for* interaction design determine how design researchers frame and understand users and contexts for design processes. They provide a frame for

¹⁷ This definition of 'theory' in a basic form. Friedman (2003) summarises various definitions from a number of authors, which show different levels of detail. For this thesis, the basic definition of theory is used.

identifying “*abstractions that can be visualised as meaningful units of analysis*” (Rodgers 2004, p. 135). They influence how researchers collect and communicate insights about users and contexts, which insights are considered, left aside, or over- or underrepresented for design processes. They (partly) also influence which design research approaches are used to inform and inspire design processes.

Insights about users and contexts describe all the user related aspects (users’ experiences, values and practices, etc.) that designers may consider for inspiring and informing their design concept; and are part of the broader design context¹⁸.. Theories *for* interaction design influence how researchers and designers scope, frame and focus the insights about users and context they use to inform their work with.

In the past, interaction design borrowed understandings from other domains, such as psychology or sociology. Approaches like activity theory or distributed cognition have shown to be too heavyweight and too complex for practical design settings. Such theories demanded too much effort in studying users and applying the results (Rodgers, 2004). Nevertheless, theories from cognitive psychology left a mark in form of language. The word *affordance* is one example. Also, theories and practices such as ethnomethodology have helped HCI and interaction design to frame design problems differently. These draw from a different set of insights, e.g. from context and situated action, rather than cognitive user models. However, these theories and their methods, e.g. ethnography (and related approaches), often led to thick and multi-layered description of practices, people and situations (Rodgers, 2004). While such insights are highly worthwhile, they can be incompatible with the needs of designers. The amount of information and the level of detail of such insights may not fit designer’s situational needs during design processes (Rodgers, 2004).

Interaction design also relies on pragmatic and design focused theories that frame and support research and design processes. Currently the most prominent agenda within HCI is *experience centred design* (e.g. Jordan, 2000). However, such agendas may be too abstract for fruitfully informing particular design settings. Therefore, recent interaction design research has explored different theories for interaction design. In this thesis, such programmatic and design-focused theories are called *middle range theories for interaction design*.

¹⁸ Insights about users and contexts belong to the design context that comprises everything from the client’s wishes, materials, aesthetics to particularities of the production chain and the production lifecycle (Krippendorf, 2006).

A middle range theory *for* interaction design is an intermediate between holistic design focused theories for interaction design, and detailed, but not generalizable, design solutions and theories for particular users and contexts. Sociology inspired the term and concept. In particular, Merton (1949) suggested to focus on segregated social phenomena rather than trying to postulate grand abstract theories that aim for validity across a broad set of social contexts (or even societies). *Middle range theories* form a middle ground between theories with high level of theoretical abstraction, and individual empirical facts. In this way, a middle range theory introduces a theoretical scope that can be empirically tested – in contrast to abstract overarching theories. It introduces a perspective that *allows asking questions, which could not be asked without it* (Merton, 1949).

A middle range theory *for* design aims to achieve similar for design purposes. It allows for the conceptualisation and framing of problems and insights for design, in a way that could not be done with holistic, overly general and abstract theories, or with overly specific design solutions or theories. *User experience* is a typical example for an overly abstract theory for design, with universal definitions (e.g. Law, 2008 or McCarthy J. and Wright, P., 2004) that often appear too holistic to inform concrete design problems. On the other side, ethnographic studies in particular contexts produce spot on insights, which however do not transfer to other design problems and contexts easily. A middle range theory for design aims for a (re)usable perspective to frame, scope and focus insights about users and contexts for design processes. Interaction design research has introduced a number of theories of this type.

For example, Zimmermann (2009) explored *product attachment theory*. Forlizzi (2008) defined *the product ecology*, which explains product use in particular contexts. Other acknowledged perspectives are *value sensitive design* (Friedman, 1996), or *worth centred design* (Cockton, 2006). Such theories are pragmatic and design focused, guiding the mode of thinking, and also the approaches and user and context focused design resources that are used to achieve desirable outcomes. These examples are middle range theories that help with framing, scoping and focusing insights about users and contexts that one designs for. Such middle range theories emerged from within interaction design rather than being imported from other disciplines. They therefore do not aim at scientific purity when collecting and communicating insights about users and contexts.

Middle range theories *for* interaction design differ from *scientific* theories. Within HCI, the research community often strives for elaborating theoretical definitions with scientific rigidity, e.g. Law et al.' (2008) work *Towards a Shared Definition of User Experience*, or Jumisko-Pyykkö and Vainio's,(2010) as well as Tamminen et al.'s (2004) work on *mobile context*. In contrast, a middle range theory's purpose is not to conceptualise and understand users and context with scientific validity, rather it is to provide *an appropriate, adaptable and usable foundation* for pragmatic design settings.

The next sub-section examines the field of *mobile interaction design* for dominant theoretical perspectives on users and contexts.

2.1.2 Theoretical perspectives in mobile interaction design

I now review four prominent theoretical perspectives in mobile interaction design and mobile HCI¹⁹. I also discuss theoretical approaches that aim to reconsider the notion of mobility for the purpose of mobile interaction design. The aim of this review is to highlight the difference between established and novel perspectives.

First, mobile HCI applies a rather *device focused perspective*, which focuses on the interaction between user and mobile device (Fallman, 2005). Design research and interaction design focuses on technical and usability issues of portable devices. Foci are mobile phones' physical product design, their interfaces and interaction techniques. Body mounted devices and wearable technologies can be seen as one strand of research within this perspective. A prominent representative is Roto's (2006) work on mobile experience. She argues for an understanding of mobile user experience that is formed by *the user, the context and the system*, which is broken down into the entities *device, browser, connection* and the actual mobile *website* (Roto, 2006). Similarly, Meschtscherjakov et al. (2014) define the design space for *mobile attachment* from a device-centred perspective. Their model draws from *user, device and environmental* factors (advertisement, other mobile devices, narratives, etc.). Design research studies using this perspective investigate experiences (Karapanos et al, 2009) or values (Leitner et al. 2008) as a

¹⁹ This may not be an exhaustive list of theoretical perspectives. Rather, the four perspectives were most relevant to the work with the Hankie Probe and proved to be a useful frame for contrasting traditional with more advanced theoretical perspectives. Neither are these four perspectives exclusive. Research and design studies may fit with one or more of these theoretical perspectives.

trait of the actual devices. Device focused perspectives draw from a range of inspirations. For example, Juhlin et al. (2013) seek inspiration from fashion design (*outfit-centric design*, in their words) for their work on the experience of mobile phones.

Secondly, mobile HCI often applies a *location centred perspective*. *Mobile context* is often understood in terms of location or geographical regions (Jumisko-Pyykkö and Vainio, 2010). The contextual perspective responds to the portability of contemporary information and communication technologies, and envisions new usage strategies, experiences or interaction styles in particular locations or geographical regions. Spaces for mobile interactions are conceived and ordered according to architectural frames, e.g. mobile devices in urban areas, at home, at the office, on transport, at the nursery, etc. Studies aim to understand such places in order to introduce meaningful mobile services and suitable interaction styles. For example, Kynsilehto and Olsson (2012) use cognitive maps to understand different *interaction profiles* in particular locations and contexts, looking at places such as gym and office, etc. Tamminen et al. (2004) looked at the dramaturgy and characteristics of walking and moving in *urban areas*. Their work is called *understanding mobile context* – hence, mobile interaction is understood as device use in locations outside buildings. Iacucci et al. (2000) and Iacucci (2001) envisioned new mobile services for a *university campus*. Nylander et al. (2009) researched the use of internet via mobile phones in people's homes.

A third perspective focuses on *practices and experiences with digital portable tools*, which looks at portable devices and their digital features, e.g. smart phones. This perspective primarily looks at usage practices and experiences. However, it also takes time and space aspects of mobile interaction into account, focusing on how mobile devices enable users to order aspects of their life in radically new ways. For example, Reponen et al. (2008) look at people's new and emerging practices of video and photo taking and sharing, enabled by mobile devices. Studies look at new practices with mobile entertainment and news services (Verkasalo, 2009), how, why, when and where people use portable video players (O'Hara et al. 2007), and how mobile devices allow new forms of work task management (Matthews et al, 2009). The use context's characteristics are a relevant feature of this perspective too. However, the main focus lies on practices and experiences with devices and their portable features taking place in a diverse set of places of everyday life.

A fourth perspective looks at new *practices and experiences of mobile communication features*, including other forms of connectedness in everyday life. This perspective is similar to the third. However, this perspective particularly emphasises new forms of *communication* with distant others, enabling new communication practices and experiences. Hence, design research and interaction design focuses on the *portability of connectedness*. It looks at practices of mediated communication, which are affected by existing and newly emerging mobile technologies. There are several examples: Palen et al. (2001) researched the adaptation of mobile conversations to everyday practices and how they allow new opportunities for coordination. Perry et al. (2001) investigated emerging mobile work practices enabled by new forms of virtual connectivity to co-workers. Ito and Okabe (2005) and March and Fleuriot (2006) researched teenagers mobile communication practices in everyday life to maintain contact with their peers. Jacucci's et al. (2007) studied new mediated forms and expressions of humour amongst groups of sport spectators. Researching multiplayer games, Licoppe and Inada (2012) identified *timid encounters*, which describe minimal and proximity-based digital encounters of people moving in urban areas. This perspective is interested in new chronologies and new places for being connected as well as in new forms of contextual appropriation; e.g. people hiding their phone beneath a table to write a text message during a meeting.

A relatively small amount of work in interaction design research explicitly rethinks traditional notions of mobility for interaction design purposes. New interpretations of mobility for interaction design are inspired by a range of insights coming from contemporary sociology, transportation research, social-geography or media studies. In this thesis, they are grouped by the term *mobilities* theories and share core characteristics. For example, they reconceptualise the understanding of place and embrace time as main factor structuring social interaction (Bauman, 2000). While in the past, social interaction was regulated by physical closeness, nowadays with the existence of communication technologies, time has replaced space as the main factor structuring social interaction (Bauman, 2000). To communicate with each other, we don't need to be physically close anymore, e.g. be in the same location. Rather, communication media allow us to connect to distant people from wherever we are. We can choose *when* we do so. Mobile technologies that have emerged over the last years have accelerated this development. However, this (still) does not mean that humans can be connected to

each other *anytime and anywhere*, which must remain a theoretical ideal. Rather, it means that people create new mobile practices, to stay in touch via communication technologies, that take place at certain times and in particular places (Schwanen and Kwan, 2008; Green, 2002).

According to new media theories, the notion of *here* and *there* is disrupted, as communication technologies transcend space and mediate distant people, information and places (Meyrowitz, 2005). Further, people, objects and information become increasingly mobile and are not fixed in space. Multiple mobilities take place at the same time, with people being physically and virtually mobile simultaneously. Recent research in sociology (Urry, 2007) goes as far as to equate physical and virtual mobility²⁰. Being connected to other people via the Internet complements physical movement. Thus, virtual and physical mobility need to be thought of as overlapping systems.

Such new theoretical developments offer a new theoretical basis for mobile interaction design. Mobile HCI can benefit from going beyond a focus on *users' interaction with portable devices in particular locations*. Some work within interaction design has embraced such novel mobility theories already.

Kakihara and Sorensen (2002) introduce the metaphor of *fluid interaction*, which suggests that static spatiality, linear clock-time and rigid contextualisation are disrupted by the contemporary societal mobilisation. This to some extent frees people's perception of others from contextual, spatial or temporal constraints and consequently leads to a mobilisation of human interaction. Inspired by sociological research, the authors discuss three dimensions of mobility, which affect social interaction, namely *spatial*, *temporal* and *contextual mobility*. This refers not only to the movement of people but also others such as objects, symbols (e.g. visual images of places) and space itself, e.g. cyberspace that is rather unlocated. For the purpose of interaction design, they suggest the metaphor of *fluidisation*, which describes social interaction as not being characterised by regions or networks, but rather as a dynamic process, in which boundaries and connections can come and go fluxionally.

Dourish and Bell (2011) discuss an alternative theoretical perspective of mobility mainly addressing urban areas. In essence, their conceptualisation is quite similar

²⁰ *Virtual mobility* refers to mediated interaction with physically distant people and places.

to Kakahara and Sorensen's. They suggest that technologies, whether mobile or fixed and together with the underlying infrastructures (e.g. Wi-Fi spots), create broad infrastructures that are (simultaneously) technical, social and cultural. This impacts the perception and usage of space. They also suggest the notion of *fluidity*, which no longer conceptualises mobility as being understood in terms of fixed boundaries, pre-figured places (and objects) and movement between these places. Fluidity refers to the essential role of technologies and practices that adapt to local circumstances and to a continuous re-adapting to these changing circumstances; it suggest flow and connectedness rather than nodes and separation.

Fallmann (2003, 2005a, 2005b) interprets *mobility as involvement*. This theoretical perspective suggests that humans are not completely freed from contextual constraints – although the notion of mobile systems for *anytime/anywhere* use would suggest so. Rather, embodied users are involved and engaged through embodied action in the actual physical place, but also in remote places to which they are connected via information and communication technologies. Fallman argues that mobile interaction design should not misunderstand *mobile context* as Cartesian location or as contextual characteristics of a location and information related to such. Rather, design should embrace a multi-dimensional perspective of mobility, with embodied users who co-exist in physical space and in distant places via information and communication technologies.

Furthermore, interaction design research has proposed new user experience frameworks that offer theoretical perspectives that inform mobile interaction design – although they are not explicitly related to mobile HCI. For example, *interaction trajectories* (Benford et al. 2009) describe users' corporeal movement alongside continuous journeys through different places, times and interfaces. Benford et al.'s (2009) work emerged from work on *cultural interfaces* and interactions in museums and galleries. However, the key-principles of this work show some overlaps with mobility studies. For example, *trajectories of interactions* emphasise the importance of time, and in particular transitions of time that form into various episodes of interaction. This, for example, overlaps with the notion of *fluid interaction*. Further, trajectories of interaction incorporate transitions in-between spaces, but also transitions and interfaces between physical and virtual domains, which form *hybrid contexts*. This has strong overlaps with Fallman's (2003) notion of *mobility as involvement*, as it considers embodied uses that are involved in distant places via information and communication technologies.

Novel mobility theories have informed a number of studies *about* technology use. This has led to a new understanding of portable device practice and experience that informs design work. For example, Weilenmann (2003) conducted a number of studies, looking at portable devices in particular places and as part of activities, and the virtual communication spaces related to them. Rather than being the exception, Weilenmann concludes that mobility is consecutively produced (“*doing mobility*”). Williams et al. (2008) studied technology use of transnational Thai retirees, who had homes in the US and in Thailand. They propose the notion of *anchored mobilities*, discussing how communication technology use is related to spatial and temporal *anchorings*. Their study shows how participants’ perception of and practice with communication devices is heavily influenced by local infrastructures, local and transnational family structures, and temporal rhythms in which they visit their homes in two countries. Williams et al. (2008) propose that looking at such *anchored mobile practices* can offer new design opportunities, in contrast to the notion of mobile device use perceived as worldwide anytime-anywhere travel.

In conclusion, theoretical perspectives determine how insights about users and context are framed, scoped and focused. A device focused perspective leads to a different conceptualisation of insights compared to, for example, a location-focused perspective, or to a *mobilities*-inspired focus. It considers a different set of insights, contemplated with a different lens. Novel mobility theories introduce alternative perspectives, which are underexploited within HCI research.

The next section will review methods²¹ and approaches²² that are used for mobile interaction design research. A method/approach does not necessarily relate to a theoretical perspective. For example, a device focused perspective can be researched using different methods and approaches, and collected insights can be represented and communicated with a range of user and context focused design resources.

²¹ In this thesis, a *method* is understood as a fixed and defined procedure structuring a design process or user and context focused design research, promising to achieve desired ends via these predefined means. A method involves a number of pre-defined user and context focused design resources.

²² In this thesis, an *approach* is understood as a loosely framed (implicit) procedure promising for potentially achieving desired ends via vaguely defined means in a design process. An approach is associated with a number of user and context focused design resources, but does not pre-scribe their visual and conceptual design, nor their (means of) application.

2.1.3 Mobile methods and user focused mobile interaction design research approaches

This section reviews user focused design research approaches that inform and inspire mobile interaction design processes. Often *mobile methods* are understood as data collection instruments for studying mobile device use. Gathered insights feed and inform the design process. In principle however, these approaches are independent from the actual design process as they mainly focus on collecting insights. In contrast, *approaches for user and context focused mobile interaction design research* consider gathering and working with insights within a design process. Therefore, they also emphasise how insights are presented and manipulated over the course of the design process.

There is very extensive research in this area. It is impossible within the space available to provide an exhaustive review of all varieties of approaches in use, but it is also not the aim of this thesis research to produce this review. Furthermore, the research literature already provides such overviews. Therefore, I will draw from Hagen et al.'s (2005) taxonomy, and extend it with my own remarks drawing from a range of representative studies. For the purpose of this thesis research, I will then pick out three user and context focused design research approaches that are explicitly designed to inform and inspire mobile interaction design. I will examine these more closely and will particularly look at the theoretical perspective that these approaches apply, as well as the user and context focused design resources they propose for collecting and communicating insights.

Hagen et al. (2005) describe three trends: a) mediated data collection, b) simulations and enactments, and c) combination of these two approaches. *Mediated data collections* rather belong to the category *mobile methods*, whereas *simulations and enactments* are presented as *approaches for user and context focused mobile interaction design research*.

Mediated data collection often requires participants to collect insights themselves, such as with Probes. These approaches are not necessarily digitally mediated. For example, Grinter and Eldridge (2003) ask teenagers to trace their texting habits using paper diaries. Hintze et al. (2010) and Sohn et al. (2008) both investigated mobile information needs using diaries. Hintze and colleagues used small card-like questionnaire sheets to provide a better way for taking notes in mobile situations. Diaries are often filled out later on - or after the event that is researched. Written

story-like reports are a form of diary, as they were used by Korhonen et al. (2010) to research mobile contextual experience.

Another strand within mediated insights collection is *digitalisation*. Hence, they make use of digital devices for gathering insights and interacting with respondents. *Mobile Probes* (Hulkko et al., 2004) or *Experience Sampling* (e.g. Intille et al., 2003) provide electronic ways of recording data in-situ, with photographs or small questionnaires used on mobile devices. Swallow et al. (2005) used voice note diaries. Respondents were given recorders to voice their thoughts onto the tape. With such approaches researchers can actively trigger or provoke respondent's feedback by sending digital prompts or questions. Mediated collection also involves data logs and makes use of wearable tools, like small and mini cameras that can be used for observation, but also include wearable sensors (Hagen et al., 2005; Büschner et al., 2010). These approaches overcome problems of traditional observation (Ichikawa et al. 2005), such as needing to be in the same location with the studied persons. In observational studies, both when done digitally or physically, people's behaviour is logged and observed. They are studied but do not actively engage in generating data.

Simulations and enactments both strive for creating a realistic usage situation in which insights are gathered. They involve *doing* and often require the researcher and designers to be active. Designers and researchers have used such approaches in the realm of mobility, experience and mobile interaction. During the course of the *urban probes* study, Paolos and Jenkins (2005) left approximately 100 postcards in an urban area hoping for random people to return them. In this way, they were expecting to learn about opinions, feelings and experiences of city life and urbanity. Büschner et al. (2010) designed interventions in urban areas, rebuilding the sharing mechanisms of social networking sites in the physical world. In a shelf-like installation, people could place, leave and take objects that they wanted to share. Such experimental approaches often make use of tangible materials and they are designed to deliver design inspiration and to disrupt perceptions. The outcome is often unclear and uncertain, but is expected to spark off ideas for innovation at early design stages.

Third, Hagen et al. (2005) identify *combination of mediated data collection and simulations and enactments*. A good example is Abowd et al.'s *paratypes* (2005), which are questionnaires that are handed out to participants together with

Technology Probes (Hutchinson et al., 2003). The approach aims to gather user feedback and first time user experiences with novel wearable/portable technologies.

Hagen et al's (2005) review looked at emerging approaches that are a result of the portability of devices. Hence, their review did not mention more traditional approaches like interview studies. Nevertheless, such traditional approaches are an intrinsic part of mobile interaction design research and are often used in combination as well, e.g. like by Grinter and Eldridge (2003) or by Hintze et al. (2010). Further, mobile interaction design also draws from theoretical sources to inspire and inform design. For example, Brewer and Dourish (2008) rethink the notion of places by drawing from aboriginal cultures' idea of *storyspaces*. Similarly, Dourish and Bell (2011) discuss cultural meanings of places and how these can inspire design for urban areas. The following statement shows how art and philosophy can be a relevant source for mobile interaction design: "*Inspired as much by the actions of the situationists as by writers and theorists such as Walter Benjamin, Michel de Certeau and Kevin Lynch, Social Tapestries and the platform we have built to support public authoring and spatial annotation (Urban Tapestries) are an attempt to investigate how we may intervene, as artists and designers, in the development of mobile communication*" (Lane, 2004 p. 6).

This section reveals that methods/approaches within mobile HCI and interaction design are often interpreted as ways of gathering and collecting data, neglecting aspects of translating and applying such insights to design settings. This is especially true for digitalised and wearable tools that offer new ways for studying and interacting with participants. Such *mobile methods* offer new ways of gathering insights, but little is known about how well these insights inform and inspire design processes. Often, these approaches' role and value for informing and inspiring design work is underemphasised. A more integrated understanding is needed looking at the entire process, from insights collection to insights use in design settings. Similar is true for Probes. For example, Hagen et al. (2005) classified Probes as tools for data collection. How particular Probes support later design processes is not discussed.

So far, the first part of this literature review has discussed different theoretical perspectives for framing and scoping insights about users and contexts for mobile interaction design. Further, different approaches for gathering and communicating

insights have been reviewed. The next sub-section presents three particular approaches, highlighting their theoretical perspective on users and contexts and the design resources' format to collect and communicate insights.

2.1.4 Close-ups on three user-centred mobile interaction design approaches

This section reviews three approaches that aim to inform and inspire mobile interaction design. Each approach examines mobile interaction from one of the aforementioned four *theoretical perspectives* and draws from different user and context focused design resources to collect and communicate insights.

2.1.4.1 Experience Characters

Obrist et al. (2011) presented *experience characters*, which are similar to Personas. This design resource presents five characters, each of which represents an experience. The five characters are: the emotional attachment experiencer, the status symbol experiencer, the critical experiencer, the practical tool experiencer and the social connection experiencer. An abstract summarises each character together with attributes the characters assign to their phones, the needs the phone fulfils and the characters' statements about the phone. An experience character is shown in Figure 2.1.

The set of experience characters aims to support design activities by providing a lively descriptions that can engender empathy. The characters are generated through a grounded theory approach based on several written experience reports. These are coded and turned into five categories, each representing one experience character.

Theoretical perspective: This approach mainly applies a *device-focused perspective*. The character *status symbol experiencer* represents this perspective well. Nevertheless, the approach also features new forms of connectedness. For example, character 5 is represented by the following quote: "*If I lose my mobile phone, I would be separated from my friends.*" However, the approach expresses experiences with mobile devices by attributing it to the device itself, which is presented as a static and decontextualised variable. This approach aims at representing a valid and scientifically grounded basis to start and inform a design process.

Design resources' format: Experience characters are presented in a scientific paper, in which the characters are presented as written texts, visually organised in boxes. They are shown with a high level of abstraction. Summaries, theoretical and partly also scientific definition of experiences are used as explanations. The presentation is only partly based on direct statements and quotes taken from the qualitative analysis. It is possible to use such character descriptions in a broad range of settings. The most probable way of using the characters is on printouts, which can be pinned on walls (etc.). The authors may have used them in different ways, but do not discuss their application in practical design settings. The presentation of the characters and their context is static. The approach does not explicitly foresee an active manipulation of the characters during design workshops.

2.1.4.2 Scenario Storyboards

Pedell and Vetere (2005) present the design resource *picture scenarios* that communicate contextual information to designers (see Figure 2.1). The approach combines scenarios and personas and displays important aspects of a mobile scenario in a story-like setting. Researchers and designers enact storylines and document them visually. The approach captures mobile experience and mobile context with photography, which is further annotated with text in design workshops. The presented design cases focus on a variety of places, but mainly show public urban areas. According to the authors, picture scenarios communicate the use context by showing activity and practice.

Theoretical perspective: The approach primarily represents a *single and multi location focused* perspective on insights about users and context. However, this seems to be a result of the case study with which picture scenarios are presented. It mainly features urban areas, but also include other places like home. The story-centred approach introduces strong elements of *new mobile practices* and *new forms of being connected*.

Picture scenarios are a dynamic approach: The active interpretation of the picture scenario with annotations allows different interpretation of the presented insights about users and contexts. The designers collect insights themselves going to places or even enact the scenarios they are looking at. There is a strong interactive element in dealing with insights. Once design ideas are generated and turned into first concepts, they are again evaluated in the use contexts and

documented. This leads to a cyclic process and the scenarios are not static but evolve over time. This means that designers extend or change their understanding of users and contexts over the course of a design process by actively manipulating and dealing with the picture scenarios.



Figure 2.1: Left: Obrist et al.'s experience characters, (2011); Right Pedell and Vetere's Picture scenarios (2005).

Design resources' format: Picture scenarios are represented and manipulated using different media. It includes elements of enactment in context, which are documented with photography and then annotated with text. Compared to experience characters, this approach is less founded on scientific analysis. Rather, it is grounded on intuitive and ad-hoc decisions by researchers and designers, who choose what to document about users and contexts. The representation of insights is therefore not static, but rather evolving, and described through various media and formats.

2.1.4.3 Contextual roleplaying and enactment

Iacucci et al. (2000, 2001) explored roleplaying in game-like settings to inspire the design of mobile services, supported by a set of individual design resources. Their approach is based on core scenarios that are acted out by users/participants and designers. For some of the described scenarios, the groups worked on a large map placed on a table (see Figure 2.2). They envisioned new services, imagining walking the city and staying in touch with each other virtually. For some scenarios, participants received a mock-device, the *magic thing*. They were asked to envision what the tool could be doing for them while they walked around on the university campus. Researchers accompanied the role-players to observe.



Figure 2.2: Iacucci et al. (2000) explored role playing, game-like settings and performance to inspire the design of mobile services

Theoretical perspective: This approach combines different theoretical perspectives on mobile interaction design. The case study through which the approach is presented looks at urban areas and the university campus. This is a *multi location focused* perspective. It looks at *new portable tools and new forms of connectedness* as it considers different actors in collaborative settings staying in touch and communicating with each other.

The roleplaying setup supported the researchers in identifying design ideas. However, Iacucci et al. (2000, 2001) discuss that being in the context helped to develop concrete design ideas rather than ideas that describe general technological possibilities. Hence, they were able to define ideas with a greater level of detail and assign them to particular practices and situations, rather than ending up with general design guidelines or vague ideas.

Design resources' format: The user context is not represented, but primarily interacted with directly. User and context focused design resources such as the *magic thing* facilitate. The performance explores the use context and design ideas emerge from this situation. Similar to *scenario storyboards*, Iacucci et al's (2000) role playing approach takes place in a cyclic process of in-situ enactment and analysis. Like picture scenarios, this approach is driven by designers informed choices, and guided less by scientific analysis. The understanding about users and contexts keep evolving during the design process.

2.1.5 Conclusion contextual literature review part 1.

The first part of this contextual review discussed theories and approaches that are used in contemporary mobile interaction design. Theoretical perspectives determine how insights about users and contexts are framed and scoped. Middle range theories *for* interaction design articulate theoretical perspectives explicitly and provide *an appropriate, adaptable and usable foundation* for pragmatic design settings. However, theoretical perspectives are used rather implicitly within mobile HCI and mobile interaction design. I have presented four prominent and currently used theoretical perspectives to frame, scope and focus insights for mobile interaction design:

- *Device focused perspectives*
- *Location centred perspectives*
- Perspective focusing on *practices and experiences with new portable tools*
- Perspective looking at new *practices and experiences of mobile communication*

I have also discussed new theoretical perspectives for mobile interaction design that are inspired by novel theories coming from research areas like sociology, media studies, social geography and transportation research. Novel theoretical interpretations can be a fruitful source for mobile interaction design. They offer new perspectives for generative design research. However, research exploring novel mobility theories for design purposes remains rare. Therefore, there is a need to identify the value of novel mobility theories for the purpose of generative design research.

The review has shown a variety of approaches that are used to collect insights about users, their contexts, related practices and experiences to inform and inspire mobile interaction design. However, Probes, questionnaires, video cameras (etc.) are mainly seen as data gathering instruments, with their role as design focused resources underemphasised. Exceptions are Iacucci et al. (2000); (2001) as well as Pedell and Vetere (2005), who discussed how their approaches supported them in going beyond collection to creating, informing and evaluating new concepts for mobile interactions.

A review of three approaches to inspire mobile interaction design discussed each approach's theoretical perspective and also how they apply design resources based on different formats to collect and communicate insights.

- Experience characters (Obrist et al, 2011)
- Picture scenarios (Pedell and Vetere, 2005)
- Contextual roleplaying and enactment (Iacucci, 2001)

Picture scenarios, roleplaying and contextual enactment have shown to inspire and inform mobile interaction design. The use and value of *experience characters* in design settings was not explicitly discussed.

The contextual literature review did not reveal any approach that explicitly makes use of novel mobility theories. Fallman (2003), Kakihara and Sorensen (2002) as well as Dourish and Bell (2011) have used their theoretical perspective for the design of mobile interactive systems. However, there are no user and context focused design resources, like Probes, that explicitly incorporate and materialise novel mobility theories. Therefore, using Probes as a means to explore and exploit new mobility theories for mobile interaction design can lead to new approaches and user and context focused design resources that include these theoretical perspectives.

2.2. Secondary Research Strands

The second part of this contextual literature review supports the two secondary research strands of this thesis research. It looks at theories describing uniform characteristics of a design process. While a number of such theories exist, each influenced by distinct design philosophical positions, this review will describe design processes with Probes from a *pragmatic and reflective* position. Embracing this position, the literature review looks at generative design process with Probes. This understanding serves as a basis for the qualitative analysis of the processes with the instances of mobile interaction trajectories via the curated Hankie Probes, reported in Chapter 6 and 7. Finally, this second part will summarise different approaches for designing Probes and discuss the potential of fabric-based handmade Probes for design communication. This last part will prepare for Chapter 8 that presents the analysis of the value of fabric-based handmade Probes in design workshops.

2.2.1. Theory of design processes

Dorst summarises two prominent stances to understand design processes (1997). First, design processes that are understood as *rational problem solving*, an understanding located in a positivistic frame of thought. A design process is interpreted as addressing rationally described design problems. The designer is a goal-seeking information processing system. *Reflective practice*, instead, defines design processes as reflective conversations with design situations. Each design situation is unique. Designers move through a process characterised by consecutive problem reframing, decision-making and evaluating until a desirable design outcome is achieved. Designers' subjective perceptions of the situation (or world) are a relevant factor. The design problem lacks full descriptiveness. The

theory of reflective practice refrains from separating research from practice, knowing from doing, and means from ends. Fallman (2003) distinguishes three accounts of design work: *A conservative account*, a *pragmatic account* and a *romantic account*. The first two accounts correspond to Dorst's two stances. The romantic account describes design work as 'black box'. A genius designer achieves a design outcome through a creative but untraceable act.

The use of user-centred methods is dependent on such theoretical understandings. In a conservative (or rational) account methods are often understood as standardised and objective instruments. In a pragmatic (or reflective) account methods are understood as approaches that require competences, with designers choosing and adapting methods to the unique design situations (Keinonen, 2009). Romantic accounts consider methods as irrelevant or non-existent. A genius designer achieves an outcome through a mystic design activity.

This thesis research embraces a *pragmatic and reflective* understanding of design processes. Hence, it interprets the work with instances of mobile interaction trajectories as a reflective (and subjective) process of problem framing and reframing, of decision-making and evaluating. Work that is related to this domain is next reviewed with a focus on generative design processes at early design stages.

2.2.2 Theory of design processes at the early front end of design

The early front end of design refers to early design stages at which ideas and opportunities for new devices and services are formed. Sanders (2010) identifies a shift towards generative research within user-centred design, which seeks to generate design ideas and novel concepts in the collaboration with users based on their experiences, values, dreams, etc. The aim of generative research is to identify design opportunities for the future. It does not focus on understanding or analysing the present exhaustively.

Löwgren and Stolterman (2004) distinguish two concepts that are relevant for design processes at the early front end of design: The *vision* and the *design concept*²³. The *vision* is a first organising principle that helps the designers to understand and make sense of the design context they are confronted with. It is a

²³ Löwgren and Stolterman (2004) also talk about *operative images*, which are intermediary states of a design concept during the design process. However, this thesis research only talks about (evolving states of) design concepts.

designer's first idea about how to respond to insights about users and contexts in form of a statement (or idea) of *what should or can be done*, opening up a rough direction for the design process to proceed. Theories *for* interaction design influence this first reaction. Designers' subjective initial reactions to a design context or to insights about users and contexts have also been called *primary generators* (Darke, 1979). This *vision* is not a fully intuitive understanding, nor is it the production of a scientifically organised or exhaustive picture of the available insights about users and contexts. Rather, it is a deconstruction of complexity (Cross, 2006).

A trait of design work is solution-centeredness. Designers structure insights about users and context by articulating *visions* and by thinking about possible *design concepts*. Rather than trying to analyse and understand the situation fully, they tend to work and address insights about users and contexts by working on a solution, e.g. a design concept. The designer's increasing knowledge about users, contexts and the design situation is represented by the evolving design concept. The *design concept* describes the evolving design idea over the course of a design process. Generative design processes can be interpreted as moving from the first exposure to the design context or to insights about users and contexts, via pre-existing or emerging visions towards a first articulated idea and finally a completed design concept (see Figure 2.3). For this thesis research, the analysis of the design process with the curated Hankie Probes will be based on emerging *design visions* and (evolving states of) *design concepts* in response to the presented insights about users and contexts.

The early front end of design is understood as a rather inductive process, characterised by simultaneously emerging problems, opportunities and solutions (Cross, 2006). This means that solutions to a problem can lead to new problems at a different level of detail – and so on. Lawson (2005) describes a consecutive process of back and forth, from the detailed to the general level, with designers using different sources to inform and further their work in a rather unstructured and undeterministic way. A key aspect is the interleaved approach to synthesis and analysis at these different levels of detail. During this process designers elaborate their visions and their design concepts (Figure 2.3).

During the process, designers make use of references and precedent (Lawson, 2004). These are existing solutions to different design problems that are however a means to deconstruct complexity for the design case at hand. References and

precedent narrow and structure insights about users and contexts at hand, and hint at possible solution scenarios. Pattern languages work in a similar way (Cross, 2006). References and precedence are similar connecting points between insights about users and contexts and design concepts. They propose possible solution frames and in doing so they structure and focus an otherwise overly complex design context.

To summarise, design processes are described as interleaved approaches of synthesis and analysis, during which designers use visions, references and precedent for working on design concepts. They also make use of user and context focused design resources to inform their work. The existing literature does not provide an analysis of Probes' role as part of this process, at least not from the theoretical perspective of pragmatic design processes. The next section will provide this review, establishing the basis for the analysis in Chapter 7, and in doing so creating the basis for the thesis' secondary research strand 2b): *The characteristics of the design process with the curated Hankie Probes and other influences on design teams' work.*

2.2.3 Probes as part of generative design processes

Probing is a generative design research approach that is located at the early front end of design. It seeks to gain ideas for future products and services informed and inspired by insights about users and contexts, in contrast to a technology driven innovation approach, for example. For this aim, Visser et al. (2005) argue, generative design research needs to look at people's dreams and fears, their aspirations and ideas about the future.

Some research constructs probing as a data-gathering instrument, where the use of completed Probes as insights for design work is seen as "*black art*" (Boehner et al. 2007). Boehner et al. (2007) criticised the *instrumental* application of Probes, typically relying on standardised probing packages with cameras, postcards, maps, diaries etc. Through this mechanical application, the approach loses its spirit and philosophy. Probe adaptations have often negated probing's core value, namely its play with subjectivity and ambiguity. This is due to a lack of methodological understanding (Keinonen, 2009). While cultural probing was initially understood and presented like an *agenda* or *competence*, the interaction design community has adopted it as an *instrument*. An instrumental view perceives methods as fixed

procedure with defined tools that achieves desired ends – independently from who and where it is applied. An agenda, instead, proposes a design philosophy, as *the right thing to do*, which can be effectuated by different means using user and context focused design resources and approaches more flexibly.

There is literature discussing the value of probing for design processes. While Probes have been proven to enable new forms of researcher-respondent relationships as well as enter spaces that traditional methods cannot access (Lucero, 2007), the current literature contains few analyses about how specific Probe designs were helpful for generating ideas, vision, design concepts, design opportunities etc. There remain significant gaps in our understanding of Probe use as part of design processes.

Mattelmäki (2006) describes probing's three basic qualities. First, the approach has explorative goals, second, it makes people's subjective worlds visible and accessible and third, it does so by users' self-documentation. During the design process Probes provide information and inspiration, allow user participation and enable dialogues: with users, amongst design teams and designers' reflective dialogue with themselves. Other work corroborates this 'definition' of probing. Graham et al. (2007) summarises probes as *humanising*, *inspiring* and (somewhat) *provoking*. Mattelmäki and Batterbee (2002) discuss Probes' empathy stimulating characteristics. Gaver et al. (2004) report how completed Probe snippets elicit fictitious but meaningful stories, which help the design team to understand and familiarise themselves with the collected insights.

Next to such overall qualities, research has identified a number of functions that Probes have during a design process. Lucero et al. (2007) discussed the Probes' power to endow focus on unrecognised aspects and insights. They help to discover new solution spaces to work in. Probing tests researchers/designers' perspective on the design situation. Gaver et al. (2004) summarise: "*Asking unambiguous questions tends to give you what you already know, at least to the extent of reifying the ontology behind the questions.*" (p. 7) Generative design processes hope to identify new directions that are worth exploring. However, Gaver et al. (2004) also described the approach as leading to direct hints at requirements and concrete ideas for design concepts: "*Sometimes the trajectory from Probes to designs is relatively straightforward, and design ideas can clearly be traced back to Probe returns.*" (p. 6).

Probing has been shown to have a framing and structuring function, helping the design team to meaningfully order and communicate collected insights in design settings. Lucero et al. (2007) discussed how probing supported them in mapping out insights about users and contexts with rich and illustrative representations of activities, location and routines. Similarly, Mattelmäki (2006) discusses different scoping and focusing approaches to present Probes to designers, ranging from the presentation of the completed Probe feedbacks to pre-analysed storylines that are supported by visual and expressive materials.

To summaries these insights from a theoretical perspective, probing is used to initially approach a design situation for developing first ideas for design concepts. Probing can frame, scope and focus insights about users and contexts, it can help to empathise with target users and opens up new routes for elaborating design visions and design concepts. Probes are part of the early front end of design, a process that moves back and forth, that takes places at different levels of detail and which is characterised by consecutive synthesis and analysis (See Figure 2.3).

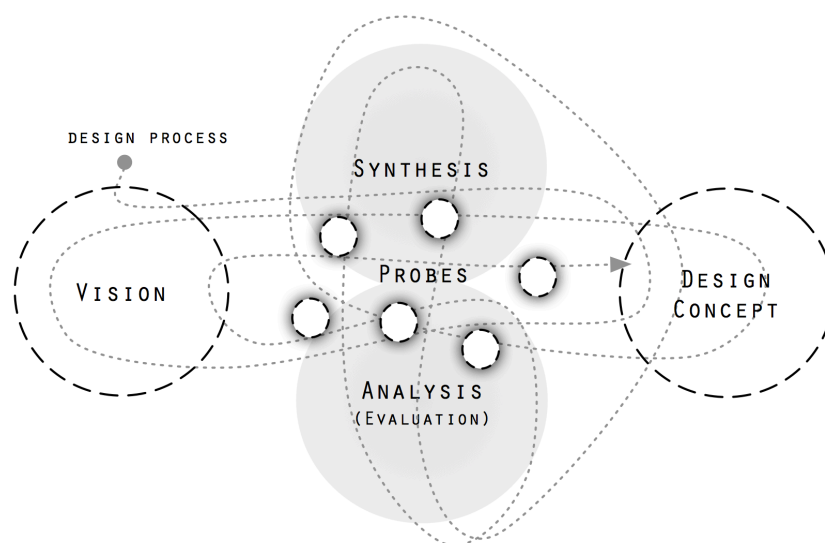


Figure 2.3: Probes' place in generative design processes: Moving from design vision to articulated design concepts. Probes are located between synthesis and analysis, between vision and design concepts.

Case Studies and research papers report such functions of probing implicitly. The research literature lacks an explicit articulation of Probes role as part of a generative design process. Chapter 7 of this thesis research will research into this understanding.

The role of theoretical perspectives for probing: Probing is not applied in a void. Probes are instead designed as a response to an initial conceptualisation that reflects a pre-existing theoretical perspective on users and contexts. Hence, the design of a Probe and its use for insights collection and communication reflects a theoretical perspective. In this way, Probes disseminate theory via user and context focused design resources and frame insights in design settings. This aspect of Probes has not explicitly been researched and articulated. However, it is visible in the literature and in case studies. This relationship between initial understanding of a users and contexts and Probe design is displayed by van Leeuwen et al. (2011), visualising their Probe approach (Figure 2.4). The Figure shows that Probes are based on the researchers' pre-existing theoretical perspective on users and contexts.

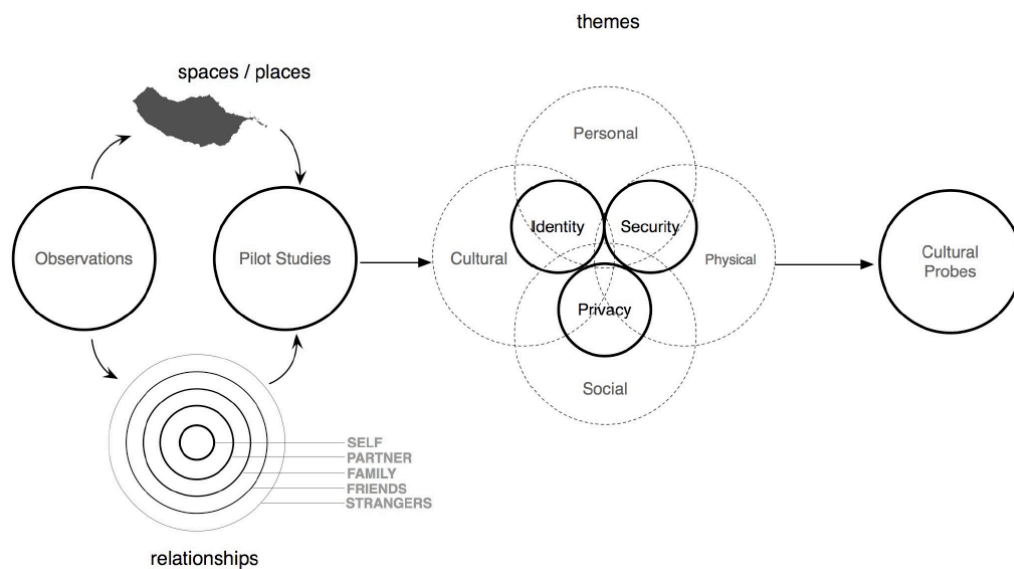


Figure 2.4: van Leeuwen et al's (2011) explanation of the process of designing their Probes indicates the relationship between the pre-existing understandings and the Probe design.

The next section will discuss the influence of different Probe designs for insights collection and communication.

2.2.4 Designing Probes Packages

For Probe design, a broad range of materials has been used over the last 15 years. For examples, Technology Probes (2003) are prototype-like interactive systems that envision and inspire new forms of interactions. Urban Probes are performance interventions in urban areas to inspire ubiquitous computer technologies (2005). Mobile probes (2004) use digital means to interact with participants using mobile phones. Wallace has introduced Probes based on craft,

using handmade objects to interact with respondents (Wallace, 2007). However, despite the variety of materials that have been used for probing purposes, the value of a specific Probe design for design communication has rarely been researched. In particular, there is no research explicitly looking at the value of handmade Probes using materials and techniques such as fabric and stitching in design workshops in HCI.

A Probe design does not only provide a format for data collection, but also determines how insights are communicated to designers. Visser discussed the relevance of careful design communication, which influences how designers will make use of a completed Probe in design workshops. Photo collages, sketches, collages, poems, postcards, photographs (etc.) are open and interpretative data sources, which represent multi-layered user contexts leaving space for creativity (Visser, 2009). The data that is communicated is multi-faceted, multi-layered and addresses issues that are both functional and affective, both general and personal, and both objective and subjective. A Probe design should expose such issues and present insights appropriately (Visser et al. 2005).

Mattelmäki (2007) presents a variety of Probe designs and discusses potential use cases of individual resources. For example, photographs can help to tell stories and create common reference points in design teams. Collages and drawings can reveal preferences, tastes or feelings, which help to create visual narratives, stimulation and shared understandings. Mattelmäki reports that careful Probe designs motivate designers to study users and to create visually appealing results. Her research also shows that designers perceive handwritten notes and doodles positively in design workshops. However, such practices remain an exception and probing is typically framed as a data collection instrument that involves giving participants a camera and a diary (Hunnington et al. 2012).

Recent work has provided a greatly expanded discussion about the role of craft in design Probes, e.g. how handmade objects can provide respondents with a frame for completion (Wallace et. al. 2012). There is a body of work discussing the use and purpose of craft-based Probes for generative design work, e.g. Wallace' work on digital jewellery (2007). Craft is seen as a way to engage with future uses of technology, as an enabler for researcher-respondent interaction, but also as a way to create a story space and to stimulate reflections. Wallace's (2007, 2012) work shows the potential of craft for insights *collection* with Probes.

This thesis research aims to contribute knowledge to the area of insights *communication*, researching and demonstrating the qualities of handmade Probes enabled through fabric, embroidery and stitching. This material and the related practices have not explicitly been researched from the perspective of design communication yet. The following and last section of this contextual review will discuss the potential benefits of fabric-based handmade Probes for design communication.

2.2.5. Communicating insights via handmade Probes

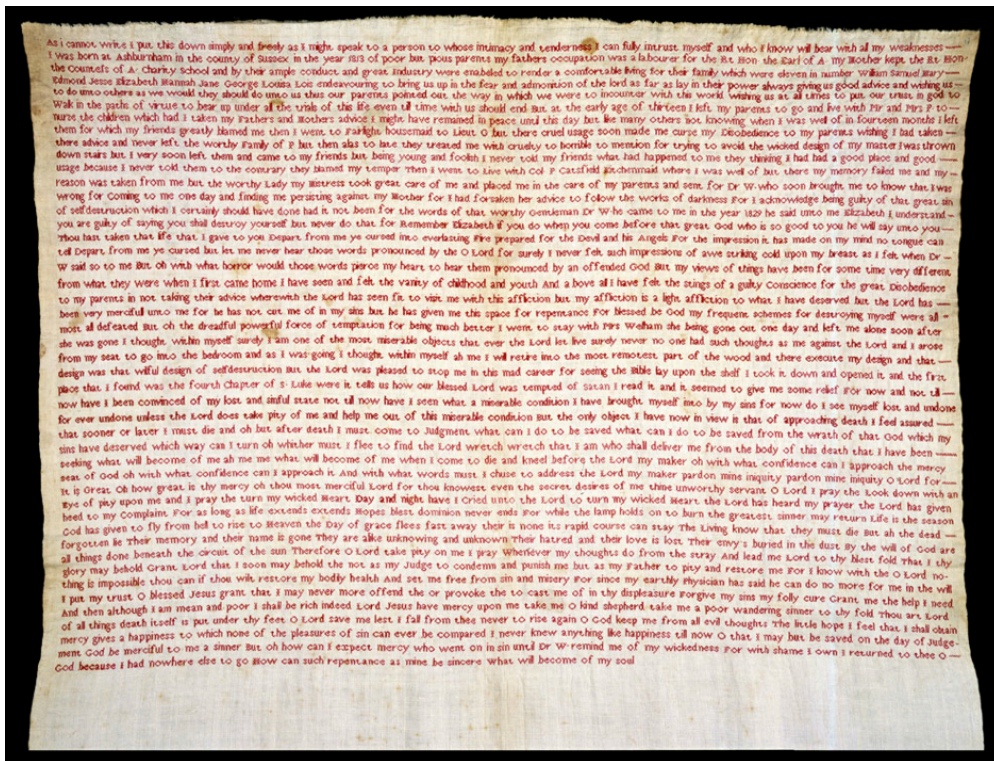
The section introduces aspects of communicating insights with handmade Probes. The review does not aim to be exhaustive. Rather, it discusses the fabric-based handmade Probe formats' potential for design communication via selected examples. The aim is to show how handmade Probes in general, but in particular those based on fabric, can be of benefit to insights communication. The aim of this section is to discuss handmade artefacts' ability to communicate insights about the maker by revealing personal styles and individual marks of completion. In doing so handmade artefacts are distinguished from mass-produced commodities.

Csikszentmihalyi and Rochberg-Halton (1981) as well as Miller (2010, 2008) discuss how everyday objects and artefacts tell us about the maker or the owner. Similar to this understanding of everyday objects, Probes can be understood as artefacts *representing the self*. Personal objects relate to stories, to things people have done and experienced. Probes aim to achieve something similar. They express and represent respondents' experiences as well as particular insights into their lives. Thus, a Probe can become a placeholder for an individual and personal story. However, many of the objects we possess are mass-produced items. So are many of the Probe formats that are in use within the HCI research community. They don't show *marks* that hint at those individual and personal stories. While handmade artefacts reveal visible traces of making, of manipulation and individual completion, mass-produced items don't show and reveal this link between story and objects. While Probes using off-the-shelf-artefacts allow respondents to choose *what* they want to document, they offer less freedom in *how* to express feedback. While this is not a problem for everyday objects, non-expressive Probe formats can limit the design resources' value for insights communication. For example, a Probe asking respondents to take digital pictures, including explicatory

text messages, will probably show less visible traces of making and completion than a sketchbook and a piece of handwritten text. Alternative Probe formats can benefit from exploiting such formats for insights communication, enabling Probe respondents to complete Probes in unexpected and personal ways. The fabric-based format that was chosen for this research aims to exploit this characteristic of handmade artefacts for probing.

The following example emphasises this characteristics of handmade artefacts: Elisabeth Parker's 'Sampler' (Figure: 2.5). It is a piece of cloth that tells the tragedy of Parker's life displayed as stitched text. The maker (Parker) is essentially an unknown person who lived in the second half of the 19th century. Llewellyn (in Kwint et al. 1999) talks about the presence of the artist that is reflected not only by the material format, but also by the process in which the artefact was completed. The material format enhances the maker's personal story, the obvious effort and suffering that has been experienced to make the object. Llewellyn talks about the artefacts creating a *presence of the author* via personal marks on the artefact (Llewellyn in Kwint et al. 1999). A similar artefact can be found in the Nordiska museum in Stockholm, named Metta Fock's complaint (Figure: 2.5). This artefact also tells a tragic and personal story that is stitched and crafted onto a piece of cloth.

According to what was discussed in this section, individual handmade artefacts have the potential to express meaning and experience. The handmade styles and the individual marks on the artefact can deepen the impression and enhance the expression of insights. The thesis research reported here aims to exploit this characteristic of handmade artefacts to benefit insights communication. The analysis in Chapter 8 will research the Hankie Probes' fabric format' value in design workshops.



pray whenever my thoughts do from the stray
 lemm and punish me but as my father to pity and
 rom sin and misery for since my earthly physician
 ke the to cast me of in thy displeasure forgive my
 upon me take me O kind shepherd take me a poor

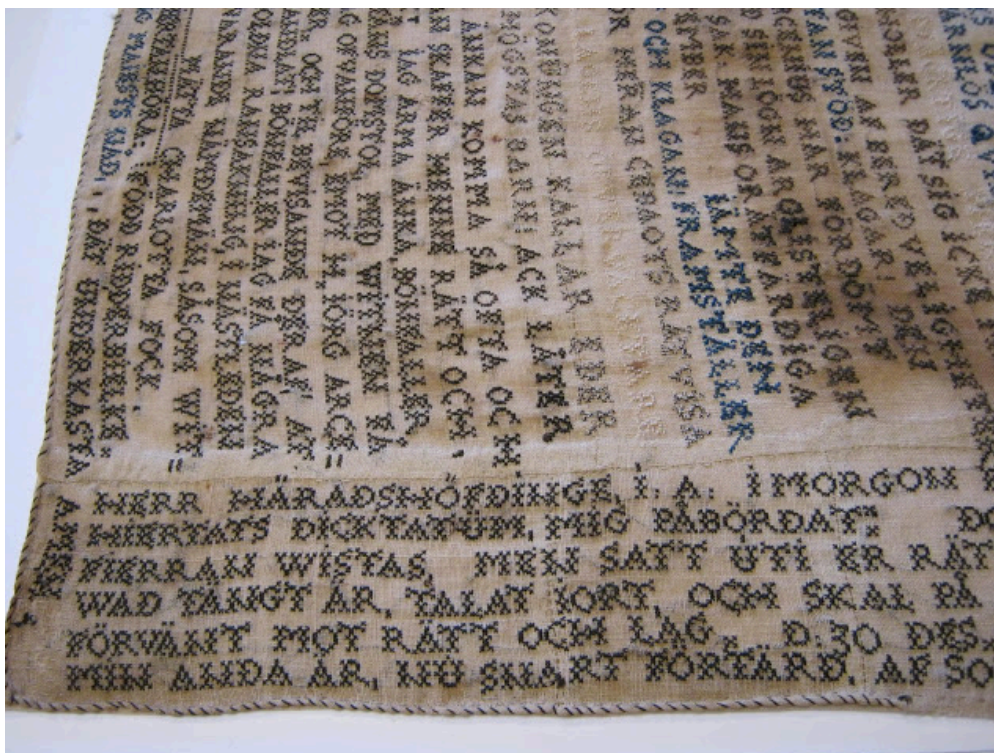


Figure 2.5: The art brut and folk art pieces show obvious traces of making, which affects the perception and interpretation of these autobiographical art pieces. Right Fock's complaint (retrieved from <http://www.digitaltmuseum.se>). Left: Parker's sampler (retrieved from <http://www.vam.ac.uk>)

2.3 Conclusion contextual literature review part 2.

Probes are used at the early front end of design. They are part of interleaved generative design processes that are characterised by consecutive synthesis and analysis. Designers make use of *design visions* to first structure insights about users and contexts. Generative design processes are solution-centred. Designers explore the design context and insights about users and context working on *design concepts*. They inform their work with different sources, including references and precedent.

As part of such processes, research has found Probes to inspire and inform design work, engender empathy and stimulate design dialogues amongst design teams. They help scoping and focusing insights on so far unrecognised aspects. These results describe the approach's general value for design. However, the research literature misses an explicit analysis of design processes with Probes that shows how designers work with the presented insights about users and contexts during their processes. There is a lack of insights exposing the Probes' functions in generative design processes. Such research could be similar to how *research about design* has analysed design sketching as a way to explore design opportunities to focus on details and to express design directions (Lawson, 2006). It could introduce a new perspective for understanding Probes as user and context focused design resources, rather than as data collection instruments.

For this thesis research, this design focused perspective is needed in order to analyse the value of novel mobility theories for generative design processes via Probes. In order to do so, the thesis research builds on implicit insights that the literature reports and which have been discussed in this chapter, e.g. that Probes respond to and represent the designers' theoretical perspective on insights about users and contexts and that they frame and scope insights. Chapter 7 will expand on this theoretical basis for understanding generative design process with Probes and – based on the findings reported in this research – contribute new knowledge to this area of research.

Lastly, the literature shows a lack of insights into the possibility of Probe designs that do not rely on standard commodities like postcards, cameras and diaries. When researchers and designers have used and explored different media to design Probes, the value of their approaches for design communication are rarely evaluated. Probes are an approach, which require contextual appropriation to

particular design settings. Existing and new Probe designs need to be researched in order to understand their value in design communication of insights. There is a focused body of work that uses craft-based Probes, e.g. Wallace's work on digital jewellery (2012). The value of such Probes for exploring new materials such as fabric, stitching and embroidery in design workshops has not been researched yet. A discussion of some handmade artefacts and related literature has shown potential benefits of Probe designs exploiting such formats. Handmade artefacts can deepen impressions and enhance expression revealing individual traces of completion and personal marks of making. New insights analysing this format can contribute to the literature about designing Probes, and also contribute to the field of design communication.

This chapter reviewed the context for this research. It presented the state of the art and knowledge areas that this thesis contributes to. The next chapter will present the middle range theory of mobile interaction trajectories.

Chapter 3: Mobile Interaction Trajectories

In this section I introduce *mobile interaction trajectories* as a new middle range theory for mobile interaction design. The theory was developed over the course of the thesis research, informed by design experiments and by novel mobility theories coming from sociology, social-geography and media studies. This chapter presents the result of this work. The theory's evolution over the course of the thesis research will be presented in Chapter 4. The following sections form the middle range theory with suitable concepts from the literature, supported by examples. The section finishes with a comparison of mobile interaction trajectories with other prominent theoretical perspectives for mobile interaction design. This chapter prepares the theoretical base for Chapters 5 and 6.

3.1 Structure of Mobile Interaction Trajectories

3.1.1. Mobile interaction trajectories as a middle range theory.

Mobile interaction trajectories is a *theory* because it proposes a model of reality, and contains descriptive and explicatory (causal) statements that allow making predictions. Further, it explains how its elements relate to one another. It is however distinct from a scientific theory, as it does not aim to research, conceptualise and understand users and contexts with scientific validity. The thesis's aim wasn't to detail and advance novel mobility theories in scientific terms. Rather, the theory's aim is to provide *an appropriate, adaptable and usable foundation* for pragmatic design settings²⁴.

Mobile interaction trajectories is a *middle range theory for interaction design* as it provides a perspective to structure insights about users and context for design problems. As a middle range theory, it is positioned between two extremes: General theories for design, such as *(mobile) user experience* on one side, and detailed but not generalizable insights and theories about specific users and contexts on the other side. It is a perspective that can structure a design problem,

²⁴ This does not mean that *mobile interaction trajectories* propose an incorrect model of reality. The thesis' research established a model of reality based on design experiments and grounded in literature. However, the theory's descriptive and causal statements inform the structuring of a design problem, rather than the formulation of scientific hypotheses. The theory's value is not determined by whether it can be proven or disproven empirically - although this could be done. Rather, the theory's value is determined by whether it is able to meaningfully inform a design process.

it a way that would be impossible (or highly unlikely) without it. However, as a middle range theory, *mobile interaction trajectories* cannot (or does not aim to) explain every mediated communication in everyday life. It offers a theoretical perspective that can purposefully and meaningfully be applied to some design problems.

The middle range theory was developed and evaluated in practice-led probing experiments (stage 2 of this thesis research), elaborating and refining it by considering the requirements of practical design settings. First, the requirements and constraints of the thesis' probing experiments influenced this work, e.g. questions concerning the type of information designers would find interesting, inspiring, informative (etc.), and at which level of detail. Second, I used objective research to inform this work, e.g. Visser's (2009) research on aspects of good design communication in practical design settings and Iacucci et al.'s (2000) research on inspiring mobile interaction design. Therefore, mobile interaction trajectories *emerged from*, rather than were *appropriated to* design settings. The aim was to form a middle range theory that shows a manageable degree of complexity for the purpose of generative design processes with Probes. Thus, its development was driven by a pragmatic design focus. The aim was to base the middle range theory on core positions of novel mobility theories. In design settings, a middle range theory can be applied in different ways. The content of the theory and its expression can be separate issues, with some mutual influences. For this thesis research, the theory of *mobile interaction trajectories* was used as a new perspective for framing and scoping *insights about users and contexts* via Probes. However, there are multiple ways to use a middle range theory. For example, it can also become an *informative resource* (Cockton, 2013) guiding and directing the design process more implicitly.

3.1.2. Core statements and theoretical aspects

Novel mobility theories suggest that social interaction is increasingly structured by time. Therefore, geographical space no longer determines and structures social interaction. Rather, time replaces space as main factor structuring social interaction. This means that humans can be connected to a distant other independently of where they are. The factor *when* becomes increasingly important for mediated social interaction. Dourish and Bell's concept of *fluidity* (2011) and Kakiyama and Sorensen's (2003) description of *fluidisation* draw from this aspect of

novel mobility theories. These theories describe connections between people as *appearing and disappearing*, with contemporary communication technologies allowing the transcendence of space. However, humans are embodied in a particular place, but virtual tethers allow one to be present and involved elsewhere almost simultaneously (Fallman, 2003). Sensitising concepts, such as *interaction trajectories* (Benford et al., 2009), offer opportunities to understand mobile interaction from a new theoretical perspective: Users' experience is formed by embodied journeys through different spaces over time, interacting with ecologies of interfaces alongside these physical passages.

Inspired by this theoretical context, Table 3.1 summarises the middle range theory's core statements.

Mobile Interaction Trajectories: Core statements
<ul style="list-style-type: none"> • Individual trajectories across different places of everyday life <i>order and frame</i> mobile connectedness. People corporeally move alongside these trajectories. • <i>Locative context</i> describes the non-mediated characteristics of the place that a person goes to as part of his/her trajectory, e.g. social, activity, product and physical context. • Communication devices are understood as <i>intermediaries</i> that connect <i>locative and mediated contexts</i>. People <i>experience distant others</i> (and places) via intermediaries. • <i>Mediated contexts</i> describe the contextual characteristics that are physically distant but electronically mediated (in real-time) and present (temporarily) via intermediaries. • <i>Moments (periods) of connectedness</i> are temporary situations in which people are connected to distant others and distant places via intermediaries alongside their individual trajectories. In these situations, locative context and mediated context(s) are of similar importance and form a <i>blended context</i>. • <i>Connectedness</i> is a <i>dynamic trait</i> that is subject to (and rooted in) everyday physical mobility. Individual trajectories, locative contexts, mediated contexts and intermediaries influence how, when and where people practice and experience mediated communication. • People have particular strategies to maintain and manage their mediated communication alongside their individual trajectories, which may also develop into <i>changing states of connectedness, chronologies of mediated communication and mobile communication routines</i>.

Table 3.1: Mobile Interaction Trajectories core statements.

The theory proposes **trajectories** as a perspective beyond the focus on single-locations, which are typically associated with urban areas or transit spaces. Instead, trajectories span across a number of places of everyday life. The context of mobile interaction is influenced by locative and mediated contexts alongside people's trajectories, rather than the characteristics of a single location in space.

Trajectories embed the notion of fluid interaction (time is structuring interaction rather than space) in the context of everyday life. The theory proposes a realistic everyday perspective on fluid interaction: People interact fluidly, but in relation to, and structured by, their everyday mobility, accepting that device users are inevitably embodied and likely to be in the same places (at the same times) over and over again.

Figure 3.1 shows the middle range theory's core constructs and how they relate to each other. Figure 3.2 offers another perspective interrelating trajectories and moments of connectedness. These core constructs are now described:

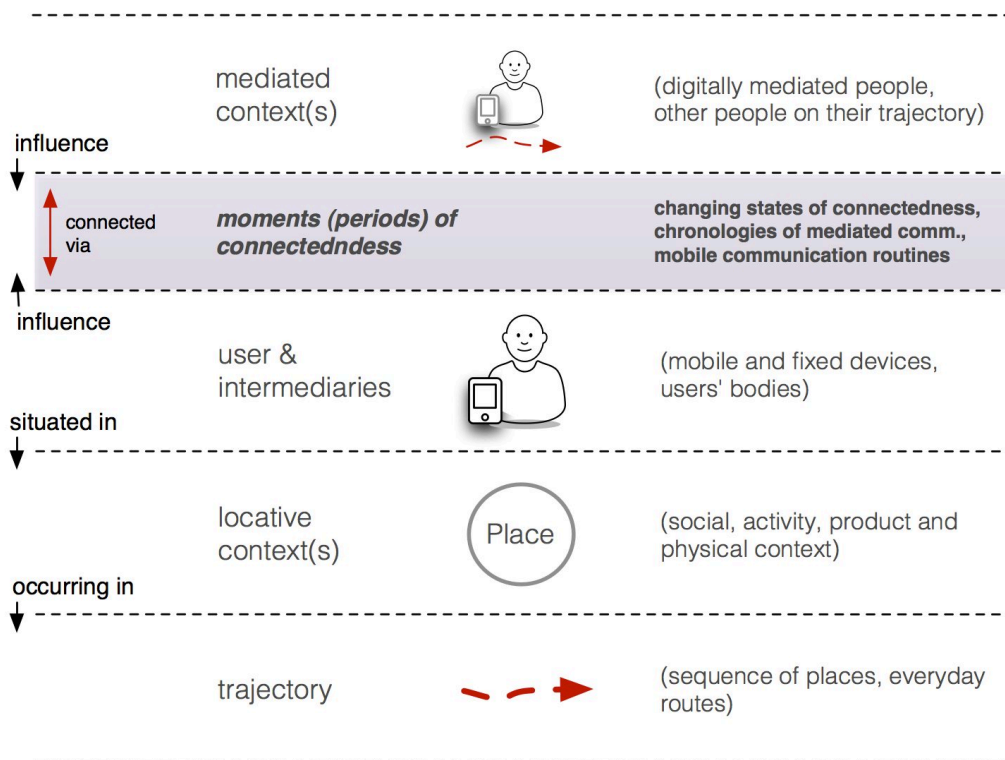


Figure 3.1: Mobile interaction trajectories theoretical aspects and how they relate to each other

Trajectories: Trajectories are understood as peoples' everyday movement structures, such as their journey to work and back, to places of leisure or shopping activities, etc. Characteristics of the trajectory describe the person's individual physical trajectory, which explains the chronology of places one goes to and also contextual characteristics. People's individual trajectories interlink the places of everyday life. Mediated communication is embedded into everyday physical mobility and in the context of "what people do" – and in doing so it creates *repeating structures* of everyday life as a core element for mobile interaction

trajectories, e.g. that people go to work on an everyday basis, most likely using the same means of transport everyday.

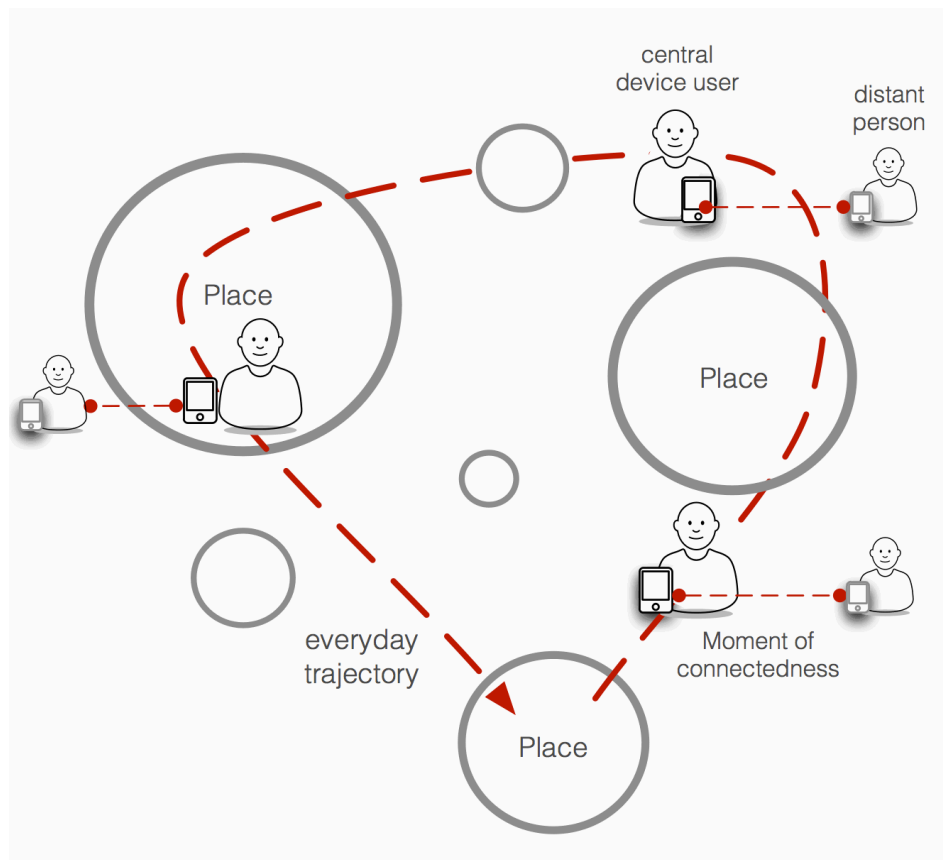


Figure 3.2: Mobile interaction trajectories: Device users are on their individual everyday trajectories crossing several places of everyday life. The middle range theory assumes that during their trajectories device users have several **periods/moments of connectedness** over the course of a day. People have particular practices and experiences in interacting with distant others during their individual trajectories, depending on places and times of a day.

Considering *mobile connectedness* as a result of – or at least as affected by – physical mobility, the middle range theory emphasises the diverse contexts of everyday life across people’s daily trajectories. Trajectories determine when, where and how people manage their virtual connections to distant others. Hence, people’s connectedness becomes related to particular places of everyday life. For example, a person may maintain and follow up mediated communications in one place, but may want to stay disconnected elsewhere, influenced by the activities and contextual characteristics in each of these places. *When moving around, people’s context changes continuously.*

Implication for design, and for user and context focused design research:

The design (research) approach should consider individual trajectories, and how they relate to one another. Further, it must allow for a multi-contextual perspective, considering how places semantically relate to each other over time and across individual trajectories.

Locative contexts: This aspect describes the non-mediated characteristics of the places a person goes to, including social characteristics, objects and digital devices, activities (what people do in this location) and the location's physical aspects, such as sound, light, build environment, etc. These aspects can include activities, work tasks and communications with co-located people, but can also incorporate insights about micro mobility, hence, how people move within a place (Weilenmann, 2003). *The locative context describes how people experience these contextual situations and the places they inhabit.*

Implication for design, and for user and context focused design research:

The design (research) approach should consider contextual aspects of the places that are part of individual's everyday trajectory. The locative context should consider aspects of the physical, social, product and activity contexts.

Intermediaries: Information and communication technologies are intermediaries. They influence the practice and experience of mediated communication.

Intermediaries display and transmit the distant. They determine how device users organise their connections, how distant events appear, and also how people experience these communicative connections. The design of a mobile device also determines the impact, intrusiveness, the volatility (or consistency) of each moment of connectedness. To stress an easy example: a video call makes a person appear differently than a voice call or a text chat. Each feature, and its particular design, affects how a distant person, event or place appears in the mediated format. Furthermore, *embodied* device users use intermediaries. The design of intermediaries influences how users can corporeally integrate their mediated communication in contexts of everyday life. For example, it is easy to hide a smart phone beneath a table to write an email. In contrast, a laptop does not allow this communication practice (that easily).

Mobile interaction trajectories involve a range of communication devices and services. Not only are portable information and communication devices, smart phones and tablet PCs an integral part of mediated communication, but also

communication via *fixed devices*, such as desktop PCs, is considered a relevant aspect of people's mobile communication too. The theory constructs *different communication services as contributing to peoples' mediated communication*²⁵, from voice or video calls to text messaging via social networking sites.

Implication for design, and for user and context focused design research:

The design (research) approach should consider information and communication technologies and services as *tethers* between embodied users upon individual trajectories. It should consider how technologies' and services' designs affect the appearance of, and communication (practices and experiences) with, distant people and places.

Mediated contexts: These are contextual aspects that are physically distant, but electronically mediated (in real-time) and present (temporarily) via intermediaries, e.g. a person speaking/appearing via video telephony, a text message (etc). This aspect describes *the mediated circumstances and the experience of being connected via specific media*. It describes the people, places, objects and information that the central device user is connected to via information and communication technologies. Mediated contexts are not passive, but dynamic entities. Incoming text messages, or push notifications via mail or social media are good examples for such dynamics. This theoretical construct also covers awareness of distant people's trajectories, their activities, moods and contextual situations.

Implication for design, and for user and context focused design research:

The design (research) approach should consider multi-contextual situations spanning a range of mediated contexts to which device users are virtually connected. Connections to these contexts must not be considered as permanent, but via moments/periods of connectedness.

Moments (and periods) of connectedness: Moments of connectedness interlink a locative and a mediated context. Each moment of connectedness creates a temporary *blended context*. Moments of connectedness result from particular user practices, and lead to particular experiences of connecting to others via intermediaries. Periods/moments of connectedness are embedded into diverse volatile contextual situations. They lead to *changing states of connectedness*.

²⁵ The terms *mediated communication*, *virtual communication* and *mobile communication* will be used as synonyms, referring to communication to distant others via a set of information and communication technologies during people's everyday trajectories.

A volatile and momentous *status of connectedness* changes constantly. The necessity, desire and conditions for being connected change during the course of the day, and people manage their virtual connections accordingly. The theory considers people's negotiation about where, when and how to manage connections to distant others, which unfolds over time and embeds into everyday embodied conduct. The chronology and places of people's trajectories condition the desire, ability, and experience and practice of being connected to others via intermediaries, forming into different *states of connectedness* over time.

Connectedness becomes a *dynamic trait* that is subject to (and rooted in) everyday physical mobility. Mobile interaction trajectories particularly focuses on people's practices and experiences when managing their interaction with distant others over time. Each *period or moment of connectedness* may be associated with a particular communication experience that is enabled and influenced by people's particular communication practices, e.g. a person's individual use strategy for email clients on mobile phones.

The middle range theory recognises that people have particular *strategies* to maintain and manage their virtual communication, which may also develop into *chronologies of mediated communication* and *mobile communication routines*.

Chronologies of mediated communication cover the varying intensities of connectedness during a trajectory (during a day). For example, a person may maintain multiple communications during a certain period of a day, e.g. during work. During other periods, the same person may be disconnected completely, e.g. in the evening²⁶.

²⁶ Mobile interaction trajectories' focus becomes more particular through consideration of different communication *purposes* and channels, e.g. mediated work communication with email and phone calls. For example, people may be logged in on their social network site all the time, but may only check news every other hour, e.g. during a short break from work. Hence, although the overall amount of mediated communication may appear as constant, looking at specific communication purposes and channels may reveal particular chronologies that are linked to particular places, appearing as single moments of connectedness

Mobile communication routines are understood as reoccurring structures of communication over time, such as regular phone calls to a specific person at a similar time and from similar place. For example, a person's daily phone call during the homeward trip from work, informing his or her partner that s/he is coming home²⁷.

Implication for design, and for user and context focused design research:

The design (research) approach should consider various moments/periods of connectedness that may form into *routines* of mobile communication, *chronologies* of mobile communication and changing *states* of connectedness over time.

These are the middle range theory's core constructs. The following definition is proposed:

Mobile interaction trajectories is a middle range theory for mobile interaction design that conceptualises insights about users and contexts by focusing on practices and experiences of changing states of connectedness, chronologies of mediated communication and mobile communication routines for a single device user, in relation to his/her physical movement patterns (trajectories), contexts of everyday life and virtual tethering to others.

The theory draws on these core constructs to understand mediated social interaction. The theory differs from other prominent perspectives for mobile interaction design. These differences will be discussed later below. The above scheme needs to be adapted to the circumstances of the design setting. Additional aspects that are relevant for the setting or the design project's aim can enrich or amend mobile interaction trajectories' core constructs and their interrelationships.

²⁷ Although mobile technologies have weakened time and location constraints for communication, many mediated communications are related to particular times and places. For example, office workers still sit at their desk from 9 and 5 o'clock and write most of their emails at this place and time. During this period they may have individual practices: They may check and respond to emails only in the morning and after lunch break. This practice relates their mediated work communication to particular times and places and may form into mobile communication routines.

3.2 Motivation, theoretical background and examples

This section outlines the motivation and theoretical sources that underpin mobile interaction trajectories with more detail. This relates the theory to the literature. The theory is backed up with examples, which were gathered in an explorative pre-study²⁸ during stage one of this thesis research (see *Chapter 4*). The findings are additional to the main results that are presented in subsequent chapters. However, the pre-study helped to establish the middle range theory. I will use insights from these studies to explain mobile interaction trajectories and to ground the theoretical discussion over the next sections. The pre-study looked at *meta conversations*. In such conversations, people maintain contact with a distant person via email or text messages over a longer period of time. Meta conversations are documented and discussed by Ito and Okabe (2005), but with little emphasis on their chronology and relation to physical mobility. The middle range theory of mobile interaction trajectories offer new ways to look at such conversations. The examples highlight different aspects of mobile interaction trajectories.

3.2.1 The relevance of physical mobility, trajectories and locative contexts

People's physical mobility is central to the concept of mobile interaction trajectories. When people physically move, they change their context. People, for example, leave home to go to work, they go to the supermarket, they go to meet friends, etc. Mobile interaction trajectories interprets a chain of consecutive place-changes as an everyday trajectory. All these places offer different conditions for being connected to distant people with contemporary communication devices. How, where and when a communication takes place is influenced by the changing social, action or physical context. In other words: the structures of everyday life, where we go, what we do, and whom we meet in different places impacts *when and how* we stay in touch with remote others. Influenced by research such as Barabasi's (2010), who argues for people structuring their everyday life in pattern-like ways (being in the same places at the same times of a day), mobile interaction trajectories presume that people repeat their individual trajectories.

²⁸ For the pre-study I talked to 10 young males at the age between 20 and 25. This was an opportunity sample. My aim was to understand how people involve text messages and their interaction with their mobile social network clients into their everyday conduct. I worked with them for a week and interviewed them afterwards. They used an adapted diary for recording, with which they took notes about when and where they used their mobile phone. During the interview I discussed each diary entry with them.

People's everyday trajectories can be understood as the initial basis for explaining virtual practices and communication experiences. The trajectory-based view is an extrapolation from mobility theories' core position: Humans rely and depend on places (Meyrowitz, 2005). Closely related to this, people are inevitably embodied. Research influenced by phenomenology has positioned the users' body as a central entity for interaction design (Dourish, 2004). Benford et al.'s (2009) work on interaction trajectories emphasises the role of corporeal movement through space and time and its influence on an overall continuous interaction experience.

Interaction trajectories lead users across several places, varying landscapes of ICT devices, interfaces, infrastructures and other physical resources, e.g. cars, tools, etc. This work strongly influenced the notion of mobile interaction trajectories and their focus on everyday movement across places of everyday life, each of which enables and offers different options and conditions for being connected to distant others.

Fallman's (2003) notion of *mobility as involvement* emphasises the role of bodies that determines how people are involved in a place – physically and virtually – and lastly also if and how virtual connection can be maintained. For instance, using a cell phone beneath a meeting table allows the maintaining of a mediated conversation without disturbing the meeting (too much). Practice of embodied involvement maintain mediated communication. However, mobile device users not only have a body, as a fixed entity in space, but one that can move. Mobile interaction trajectories expect people to constantly move their bodies through particular trajectories. Research on people's everyday movement structures shows that such trajectories are a recurrent aspect of everyday life (Blunden 1977; Herry, 2012). Trajectories like *home-work-home* are the most prominent ones, which repeatedly lead across familiar paths and places.

Embracing *trajectories* rather than *single locations* such as work, home or the urban area challenges a focus on such geographic entities, which can constrain the starting point for generative design to a particular location. Novel mobility theories suggest that locations should not be the primary factor structuring social mobile interaction. Hence, trajectories look at mobile interaction beyond one specific location, but without downplaying the significance of contextual aspects and the role of locations.

Novel mobility theories, like Urry's (2007, 2010) mobilities framework, consider virtual communicative tethers to distant others *as a form of mobility*. Thus, physical

and virtual mobility intersect and affect each other. His theory therefore looks at mediated social interaction taking place at the *intersection of two mobilities*. It draws from the increased possibility for being connected due to the portability of communication devices, and therefore from the increased possibility of mediated communication due to the newly emerging services that enable one to stay connected. This allows for new forms of being connected to others. Mobile interaction trajectories' foundation therefore is that people move through everyday life corporeally. During their individual trajectories however, people are connected to various people via different communication devices, who are physically remote, but present via information and communication technologies.

Tethered device users on their individual trajectories: In each *moment of connectedness*, a central device user connects to a distant person. This other person is also on an individual trajectory. In this way, the chronology and flow of individual trajectories is intertwined. They are responsive to one another through (bi-directional) communication.

Example - Tethered trajectories: Quotes from the pre-study interviews indicated how distant contexts and other people's trajectories influence mediated communication. For example, one participant recalled a text message he wanted to send to his girlfriend. He waited until he was sure she was awake. The message was timed according to another person's context and trajectory. Another example indicates how awareness about other people's context influences media choice. The participant recalls: "*I was in my room and he was downstairs [note: in the same flat]. He texted to say that somebody was coming round for the rugby. He was in his room with his girlfriend. I was upstairs in my room. My girlfriend was with me.*" Clearly, the two persons knew about their situation being in the same house. However, the example still highlights how communication's target contexts influence media choice. The examples show that the awareness of other people's trajectories, their routines and contexts is an essential aspect of mediated communication.

Juhlin and Weilenmann's (2013) concept of *screen mobility* describes this rising awareness of distant events, which we feel as present with us via technology, e.g. when we become aware about mediated events/situations that appear on mobile phones' maps (or similar). However, such linkage between trajectories is not only informative, technical and administrative, but goes beyond knowing where other

people are and what they are doing. The bond between people being on their individual trajectories is also characterised by a *raised awareness and emotional tie* that intertwines individual paths with each other. Benford introduced the term *experience trajectories* (2009) to describe the dramaturgy of aligned user journeys in interactive games. Similarly to his concept, the middle range theory of mobile interaction trajectories considers multiple individual trajectories in everyday life that are tethered to each other, on both a practical and experiential level. Based on this, the context of mobile connectedness is therefore characterised by the chronology and places of multiple trajectories including the contextual aspects alongside these individual paths.

3.2.2 *Blended contexts*: connecting locative and mediated contexts

The theory of mobile interaction trajectories is inspired by Meyrowitz's (2005) uses of the terms *local* and *global*. The term *global* refers to the sum of remote people: objects and places that a device user is connected to, which here is called as the *mediated context*. The *local* is all characteristics of one's immediate physical location, e.g. the social, physical or work context. For this thesis research, this is called the *locative context*. During *moments of connectedness*, the local and the global blend to create a new *blended context*.

Information and communication technologies (ICTs), the actual designed devices and services, are the tether between the local and the global. They act as transmitting and displaying intermediaries. Therefore, *moments of connectedness* need to be seen as points during people's everyday trajectories at which they connect with distant others. In these situations 'places are doubled' (Moore, 2004) for a certain period of time. This means that using communication technologies, people connect to distant others but remain physically local. In the area of augmented real-world multiplayer games, this fusion has been described by terms like *hybrid ecologies* (Crabtree and Rodden, 2008) and *locative media* (Souza e Silva, 2007). In the context of *interaction trajectories* this temporary blend of physical and virtual environments is called *hybrid spaces* (Benford et al., 2009). These concepts refer to the blending of locative contexts and mediated contexts.

Example – Forming a blended context: One pre-study participant maintained a mediated conversation with a girl. Sometimes they did not exchange messages at all. However, sometimes the exchange of messages was very active, with a number of messages over a short and intensive period of connectedness. In such periods, not even a basketball game with his friends could stop him from following up on this conversation. During a casual game, he got his phone out, wrote a reply and then continued to practice his free shot again. He also kept the conversation up while playing a racing computer game with his friend and used the time in-between races to text back and forth with the girl. From a distance, it would seem that during these periods he was seamlessly connected with her. However, for each text message he partly disengaged from the co-located people to join the meta-conversation. He manages his moments of connectedness, integrating and aligning each text message in his locative context. With each moment of connectedness, a blended context was formed.

3.2.3 Chronologies of mediated communication

Research has used the term *hyper-connectivity* to refer to the multi-dimensional simultaneous connections to remote humans, places and communities (Harper et al., 2008). This new possibility of being connected to others via communication technologies does not turn the majority of people into nomads, who are here today but elsewhere tomorrow, as some scholars have argued in the past (Kleinrock, 1996). Not only advertisers, but also scholarly articles, like to depict mobile device users as people hanging out in remote and deserted landscapes, walking through woods and sitting on boats when they connect to others virtually. The paradigm of being connected *anytime/anywhere* is however only a romantic and hypothetical ideal. Clearly, mobile devices help to stay in touch from exotic places, but at the same time such situations are the exception rather than the rule for most people. Instead it is highly probable that people are in the same places at the same time over and over again (Barabasi, 2010).

Example – Communication chronologies structured by contexts of everyday

life: Examples from the pre-studies showed that the time and place of meta conversations is negotiated based on multiple contextual characteristics. Some respondents' comments show the influence of the locative context's characteristics, like the following: "*She text me earlier, but I decided to respond to her later. It was a bit busy, so I wanted to wait until it was quieter again. It is often that I wait for these moments where you can get back to send some text messages, to check email, facebook, twitter, etc...*" This quote expresses a particular chronology of mediated communication influenced by a context's changing characteristics. The chronology is a result of the respondent's activities and contextual characteristics. Other examples showed that people find changing opportunities for mobile communication across different contexts of everyday life. A participant's quote highlights this aspect: "*Sometimes I am on the toilet. I'm sitting there doing nothing. This is one of the main places where I check my phone, to write and to check messages.*" The examples show how locative contexts regain importance, as Meyrowitz (2005) proposes, as they are essential for mobile connectedness - because they can provide optimal/restrictive conditions for mediated communication.

As a consequence, mobile interaction trajectories consider hyper-connectivity to play out in the more realistic contexts of everyday life. Hyper-connectivity spreads over people's everyday trajectories, with varying intensities over time, organised in particular *chronologies of mediated communication*. The theory of mobile interaction trajectories looks at people's practices and experiences managing this hyper-connectivity as part of their everyday life. This can be understood as *episodes of interaction* (Benford et al., 2009), including temporal transitions between *episodes*. However, in everyday life episodes are not designed, as they may be in interactive museum or theme park installations. Rather, episodes of interaction are practiced and *produced* by the users in relation to their everyday trajectories and activities.

3.2.4 Mobile communication routines

Mobile interaction trajectories assume that mediated communication shows similar *repetitive* traits as people's physical trajectories. Everyday trajectories rerun, e.g. those from home to work and back. Similarly, staying in touch with others through technological means can take place repeatedly too. Clearly, some communications are one-off cases. However, many mobile communications take place in recurring structures. Examples of such routines are diverse. For example, statistics show

that 48% of 18 to 34 year olds check their Facebook account as soon as they wake up²⁹. This routine describes people as connecting with their peers repetitively at a particular time and place. Barabasi (2010) describes a repeating structure of email management. Grounded in empirical evidence, he explains how he accesses his email account with a repetitious routine over time, dependent on his places and type of work (2010). Schwanen and Kwan (2008) discuss how homeward trips after work are used for private business arrangements. People access other space-times at this point of their trajectory because they are in-between other commitments. Such examples show that some mediated communications follow *routines* that are deeply embedded into the structures of everyday life. As these structures reoccur to a certain extent, mobile interaction trajectories as a middle range theory presumes that mediated communication with others also reappears in repetitive ways. One can understand such structures as *mobile communication routines*.

Example - Everyday trajectories and mobile communication routines: The pre-study revealed mobile communication routines. These show how hyper-connectivity is structured by people's individual trajectories, turning into mobile communication routines. One respondent embarked on the same trajectory everyday. He got up in the morning, walked to university and returned in the evening. His mornings and evenings showed mobile communication routines with distant others, e.g. text messages in the morning and evening to say good morning or good night to family and friends. The participant explained: "*It's a ten minute walk. I have time to send a message and stuff. Yesterday I was walking with J. and R. and I usually send a message. So, while we walk in I just switch off [note: from the conversation with his friends], to send a message saying 'How are you? Good morning!'*" Talking about messages in the evening he explained: "*This is something that I'll probably do most nights. I send my girlfriend a text saying 'Good night', and I check my facebook before I go to sleep and equally when I wake up in the morning.*" Not surprisingly, it was typical for this respondent to be at home at this time, sitting in his bed, at the breakfast table or walking to university on the same roads. These moments of connectedness became related to these places forming a routine.

²⁹ <http://thinkmarketing.org/2011/01/obsessed-with-facebook-statistics-facts-for-2011/> - accessed on the 28th of October 2013

3.3 Contrasting theoretical perspectives for mobile interaction design

In this section I will compare mobile interaction trajectories with other perspectives on user-centred mobile interaction design, which have already been discussed in Chapter 2. The aim is to highlight the theoretical perspectives' different foci for generative design processes. This helps to identify and describe mobile interaction trajectories' unique characteristics. For this comparison, each perspective is presented with theoretical rigidity. This means that the concepts are interpreted in their theoretical extreme, e.g. *context centred approaches solely look at one place to gather data. This is where insights are gathered and the design response is targeted at.* This stance is maintained even though such pure forms of theoretical practice hardly exist. In reality perspectives mutate. One design approach is likely to integrate different theoretical perspectives. Theoretical rigidity however is helpful to juxtapose mobile interaction trajectories with other perspectives in order to highlight potential similarities, differences, advantages and disadvantages.

3.3.1 Existing theoretical interpretations of novel mobility theories

Novel mobility theories emphasise two aspects. First, they pick the timeliness of interaction as a central theme. Their core argument is that interaction is structured by time rather than space. Second, a core aspect of novel mobility theories is social interaction, because they stem from contemporary sociology and media studies. Consequently interpretations of novel mobility theories for the purpose of interaction design show this trait too. *Mobility' as involvement* (Fallman, 2003) discusses how people appear in immediate and in distant places. Kakiyama & Sorensen (2002) discuss issues of (asynchronous and synchronous) coordination, interruption and orchestration between physically remote people. Mobile interaction trajectories show these traits too. The middle range theory looks at social mobile communication, but frames insights about users and contexts with two particular characteristics:

- *A trajectory-based perspective that interlinks places of everyday life.* The middle range theory roots mobile connectedness and mobile communication in everyday trajectories that cross a range of places/contexts of everyday life.
- Rather than emphasising *fluid* (constant) mediated communication, mobile interaction trajectories focuses on *practices and experiences of changing states of connectedness, chronologies of mediated communication, and mobile communication routines.*

Existing theoretical Interpretation of novel mobility theories	Mobile interaction trajectories
<ul style="list-style-type: none"> • Interaction is structured by time not space • Interaction takes place <i>fluidly</i> (<i>constantly</i>) over time. 	<ul style="list-style-type: none"> • Interaction is structured by time and space, rooted in everyday trajectories • Interaction takes places with changing states of connectedness, following interaction chronologies and routines.

Table 3.2: Differences between interpretations of novel mobility theories and mobile interaction trajectories.

These two characteristics make the theory distinct from other interpretations of novel mobility theories within interaction design and HCI. Other aspects of mobile interaction trajectories, such as mediated and blended contexts, are not new to interaction design. Hence, they are not listed as particularly distinct aspects here. It is further helpful to contrast mobile interaction trajectories with other dominant approaches for framing mobile interaction design. This allows positioning the middle range theory in a broader theoretical context.

3.3.2 Device focused perspectives to inspire and inform design

Device focused approaches focus on the actual mobile information and communication technology. The focus is on devices and services. Inspiration and insights that inform design are gathered by looking at the actual technology. The main focus lies on the experience and practice of interacting with the device, somewhat independently from where and when it takes place. In addition, device focused approaches consider experience factors rather independently of the context mobile devices are used in. Approaches like experience characters by Obrist et al. (2011) only partly refer to the experience of connectedness, on which mobile interaction trajectories mainly draws. The particular design of devices and their features is a secondary concern. In addition, the theory cares less about insights that depict mobile devices as status symbols or fashionable products. The theory 'downplays' the importance of device related usability and experience factors. This is a limitation of mobile interaction trajectories. The theory's main focus lies on the mobile device as a portable medium and it looks at people's practices with features, as well as drawing from people's experience *of being connected* over time.

Device focused perspectives	Mobile interaction trajectories
<ul style="list-style-type: none"> • Focus on interacting with devices and related practices and experiences • Contextual characteristics are of minor importance 	<ul style="list-style-type: none"> • Focus on practices and experiences when communicating through devices • Contextual characteristics of multiple places are a relevant factor

Table 3.3: Differences between device focused perspectives and mobile interaction trajectories.

3.3.3 Single-location focused perspectives to mobile interaction design

These theoretical perspectives understand mobile interaction as a (single)-location-centred phenomenon. Design approaches that embrace this perspective are often pre-determined by traditional geographical frames. For example, they focus on mobile devices for the *home*, mobile devices in *urban areas* or mobile devices for the *car* (*etc.*). User-centred inspiration is sought in the location that the design proposal will address in response. In contrast, the middle range theory looks at trajectories that *interlink* these locations with each other practically and semantically – looking at sequences of places, not at isolated locations. It does not predetermine a specific location to design for from the outset. Rather, it predetermines an individual trajectory that may cross several places.

Single location perspectives	Mobile interaction trajectories
<ul style="list-style-type: none"> • Focus on contextual characteristics of a single location • <i>Context</i> is interpreted as the characteristics of a location (mediated characteristics are NOT considered) 	<ul style="list-style-type: none"> • Focus on contextual characteristics of multiple places. • <i>Context</i> is interpreted as a momentary situation formed by <u>locative</u> and mediated contextual characteristics.

Table 3.4: Differences between single focused perspectives and mobile interaction trajectories.

Contextual research draws from contextual factors of a location (e.g. Korhonen et al, 2010). The term *mobile context* basically refers to contextual situations in geographical spaces that are understood as mobile usage locations (Jumisko-Pyykkö and Vainio, 2010). Pedell and Vetere's (2005) as well as Iacucci et al.'s (2000) work has shown contextual factors as a valuable and fruitful source for user centred design. Mobile interaction trajectories draws from such contextual aspects to inform and inspire design too. In contrast, this theory does not *only* consider *locative contextual* situations, but also considers mediated context in form of *blended contexts* of momentary nature. Hence, physically co-located and remote contextual characteristics play an equally important role.

3.3.4 New mobile tools, practices and experiences that inform design

Design research about, and the designs of new mobile tools (and the related practices and experiences) share a common focus with mobile interaction trajectories. Both perspectives consider portable tools that enable people to organise their lives differently – in terms of when, where and how they are able to do certain things. For instance, a study showed that portable video players allow people to consume media in new places and at new times. They let users fill waiting times or share media in ways that were not previously possible (O’Hara et al., 2007). Similarly, mobile interaction trajectories look at the *portability of communicative* tethers between people. It looks at new forms of being connected. How, when and where people do so, and their experience of being connected, is an important informative and inspirational source for this theoretical perspective. However, compared to new mobile tools perspectives, mobile interaction trajectories particularly focus on routines and chronologies of use, which distinguish the middle range theory from this theoretical perspective.

New mobile tools	Mobile interaction trajectories
<ul style="list-style-type: none">Focus on new practices and experiences with devices (including new communication practices) at new times and in new places.	<ul style="list-style-type: none">Focus on practices and experiences with devices over time and space, forming into new chronologies and routines of device use, with a focus on mediated communication.

Table 3.5: Differences between new mobile tools perspectives and mobile interaction trajectories.

3.4 Conclusion

This chapter introduced a new theoretical perspective for framing insights and expectations about users and context for mobile interaction design, in form of a middle range theory for interaction design called *mobile interaction trajectories*. This theory is influenced and inspired by novel mobility theories from sociology, social-geography, media studies and interaction design. Mobile interaction trajectories belong to the group of work that provides new theoretical perspectives for interaction design inspired by novel mobility theories, e.g. Kakiyama and Sorensen (2002); Fallman (2003, 2005) or Dourish and Bell (2011). The middle range theory differs from other theoretical perspectives with its strong rooting in physical mobility of everyday life. It draws from the practices and experiences of mobile communication alongside people’s *individual trajectories*.

It is the aim of thesis to explore and research this theoretical perspective and its value for generative design processes. In particular, it is the aim to analyse the value of middle range theory's distinctive characteristics. The next chapter will present the thesis' methodology, including the two main probing experiments that informed the thesis research. Chapter 5 will show how the theory informed the Probe design, and will present instances of mobile interaction trajectories that were collected in the two main probing experiments of this research. Chapter 6 will then show how the theory's aspects can inform and inspire generative design processes.

Chapter 4: Methodology

This section gives an overview of the research methodology. The thesis research was structured in three stages (see Figure 4.1). Each stage was characterised by a different research approach – starting from explorative pre-studies to practice-led probing experiments to analytical research *about* design. Hence, I started applying a *research through design* approach (stage one and stage two), which changed into being a *research about design* approach at stage three³⁰.

During the **first stage** I conducted a number of explorative design pre-studies, which informed the following stages. At this stage I explored aspects of novel mobility theories, as well as different methodological approaches related to exploring, collecting and communicate insights about users and context to support mobile interaction design.

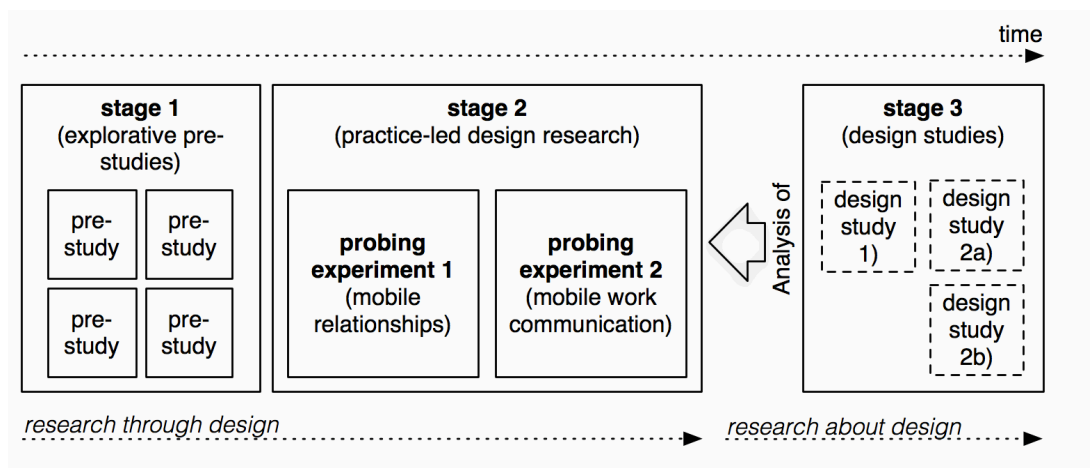


Figure 4.1: The research methodology is characterised by three stages, each of which embraced a different research attitude. The three types of research in design (explorative pre-studies, practice-led design research, design studies) are inspired by Fallman (2008).

The **second stage** is central to this work and practice-led. I conducted the two main probing experiments. For both experiments, I designed and applied the Hankie Probe. The two probing experiments collected instances of mobile interaction trajectories and used them in design workshops. I documented the insights collection and the design workshops that used the curated Probes. Two types of design work characterised this stage, turning it into a *research through design* approach: A) The *thesis researcher* designing and using the Probe for

³⁰ As discussed in Chapter 1, this thesis' overall approach is *research for design*. The thesis' results address design researchers, who inform and support design processes by offering designers insights about users and contexts.

insights collection and communication and B) design teams working with the curated Probes in design workshops.

During stage two of the thesis research I kept a biweekly research diary, which I used to reflect on the practice-led probing experiments and on my progress during this stage of the thesis research.

At **stage three**, I qualitatively analysed the design workshops with the curated Hankie Probes, analysing the resulting design concepts as well as the design teams' processes via transcripts and videotapes. I conducted three *design studies* with a different analytical focus, in line with the primary³¹ and the two secondary³² research strands of this thesis research.

4.1 Approach: Research through/about design

The first two stages of the thesis research followed a research *through* design methodology, which is a relatively new approach within HCI. It exploits designing as the central research activity. Research questions are addressed with the skill-set of a designer and addressed as part of a design process. The research outcome can range from material artefacts to immaterial services, which are accompanied and contextualised by articulated problem statements, annotations or textual discussions. The artefact and its description, purpose, annotation, discussion (etc.) form one research output. It represents the designer's knowledge, constitutes a response to a problem, hints at solution scenarios, shows new ways of working, new forms of theory use, novel ways of addressing user needs, etc. (Zimmerman, 2007).

Gaver (2012) argues such research outcomes can demonstrate how a theory plays out in practical settings. The artefact and its discussion act as a manifestation of a design theory or philosophy. Due to the multiplicity of design settings and situations, the 'irrevocability' or 'truth' of a design theory or a design outcome cannot be claimed. Such outcomes need to be understood as provisional and aspirational (Gaver, 2012). Hence, it needs to be considered in relation to the

³¹ Primary research strand: The value of mobile interaction trajectories for generative design processes

³² Secondary research strands; 2a) The characteristics of the design process with the curated Hankie Probes and other influences on design teams' processes and 2b) The value of fabric-based handmade Probes in design workshops

design setting it was developed in. For this reason, research *through* design needs a discussion of design outcomes, which allows the research insights to extend beyond the practical settings it originated from (Zimmerman, 2007). For example, the HCI community has been informed by *strong-concepts* (Höök & Löwgren, 2012; Stolterman and Wiberg, 2010³³). Similar to middle range theories *for* design, these form a middle layer between abstract theories and design instances. Such strong concepts develop from a series of particular settings but are described holistically and abstractly. They form a design reference. This makes outcome of research through design applicable to other design settings and problems.

The *design outcome* of this thesis research is a methodological artefact and its discussion: *The Hankie Probe*. It was achieved in stage 2 of this research. The Probe was designed and developed for, and applied, in practical design settings. The completed and curated Hankie Probes reflect the middle range theory of mobile interaction trajectories *for* mobile interaction design, documented by a *design resource portfolio* presented in Chapter 5. Furthermore, Chapter 5 provides an extended description and reflective analysis of this design outcome.

A research *through* design approach allowed developing a theory for interaction design from practice-led design settings, expressed via a design resource portfolio of raw and completed Probes. The resulting theory emerged from the design setting, rather than being imposed on it. This aspect, enabled by the research through design methodology, is a relevant factor for the usability of theories for interaction design (Rodgers, 2004), making it a suitable methodology for this thesis research. As described in Chapter 3, practice-led design experiments allowed elaborating and refining the theory by considering the requirements of practical design settings. This will be further reflected on in *Chapter 9 Conclusion*.

The third stage of the thesis research was characterised by research *about* design. The curated Hankie Probes and their use became the object of study. Chapters 6, 7 and 8 present aspects of the Hankie Probes' value for generative design processes. They do so by qualitatively analysing the design processes using the Hankie Probes. These chapters provide evidence for the generalizability of this thesis research.

³³ Stolterman and Wiberg (2010) talk about *concept driven interaction design*. Their work overlaps with Höök and Löwgren's *strong-concepts* insofar as it is concerned with *interaction design concepts* that act as a *design reference* for future design and research settings.

4.2 Understanding of design processes with Probes

This research uses a *pragmatic account* of design processes (Dorst, 1997, Fallman, 2003)³⁴, as described in Chapter 2. A design process is seen as a designer's situated and reflective conversation within a design context, which results in a tangible outcome, e.g. a design concept. Designers are in charge, they frame the design context and guide the process. They act according to their background, skills, interests and ideas (etc.). They make use of design approaches and exploit design resources, e.g. personas, storyboards, (etc.) and access local resources, e.g. aspects that the design setting makes available to them, like knowledge of other designers, specific design tools of a particular workshop, etc. For this research, the pragmatic perspective was the most suitable as it assumes a situated design process that can be documented and analysed, without neglecting the designer's role and the relevance of the design setting.

I consider *Probes* as user and context focused design resources that are used pragmatically within a *generative design process* – as described in Chapter 2. In this thesis, *probing* is understood as user and context focused design research that uses Probes for collecting insights in collaboration with Probe respondents to communicate them to designers. A *Probe* is understood as one or more user and context focused design resources for collecting and communicating informative and inspirational insights about users and contexts in design settings. It is a designed artefact in itself, aiming to evocatively and creatively engage participants in open subjective self-reporting activities, to an extent and in a format that fits the requirements of respondents and the design setting. Collected insights are consequently used to inform and inspire design processes. Probing is understood as an approach guided by the competence of user and context focused design researchers.

A *probing experiment* starts with the design of a Probe and ends with an articulated design concept (See 4.5 – later in this chapter). In this thesis research, *user and context focused design research* is made independent from the *generative design process* itself. Both types of design work contribute to probing

³⁴ Fallman (2003) further describes a conservative and romantic account of design. A conservative account is based in a rational understanding of process that leads a designer from problem identification to problem solution in a fully transparent and rational process. The romantic account of design, interprets design work almost as a creative conundrum that leads a genius designer to a design outcome in course of an 'untraceable' and magic process. Both these perspectives seemed unsuitable for the purposes and aims of my research.

experiments³⁵. However, *user and context focused design research* is understood as a design researcher's work to inform and support design processes by providing designers with insights about users and contexts, e.g. the collection of insights via design resources, such as Probes. The work is primarily focused at collecting and communicating insights. In contrast, a *generative design process* is understood as designers' consecutive work³⁶ over a period of time that aims to innovate and uncover new product and services inspired and informed by insights about users and contexts. A generative design process starts with the presentation of insights and ends with the articulation of an agreed/satisfactory design concept (see Section 4.4.2).

User and context focused design resources bring particular values to particular design settings – depending on how they are designed and applied. These are the *resource's functions*. This view is inspired by the Cockton's Working to Choose (W2C) framework, which has been developed recently (Cockton, 2009; Cockton, 2010; Woolrych et al, 2011, Cockton, 2013). Using the W2C framework, probing is seen as a competence (Keinonen, 2009). It regards design resources, such as Probes, as independent from fixed methodological procedures. The notion of design resources gives credit to the actual resources, thus their design has consequences.

This overall perspective allowed me to research the value of the Hankie Probe as a designed artefact that disseminates theory via user and context focused design resources. A pure *instrumental method perspective* (Keinonen, 2009) would not have been suitable for this research. This perspective attributes the value of approaches like probing, personas (etc.) to a fixed existing procedure that is not affected by who, how and in which design settings they are applied. The design resources' non-procedural roles, theoretical background and actual design are often neglected. In contrast, perceiving the Hankie Probes as a design resource within a pragmatic and reflective design processes leads to researching its functions, as introduced by its theoretical foundation and fabric-based format.

³⁵ This perspective may differ from other understandings of generative design processes, which may see the collection of insights about users and contexts via design resources as well as the interaction with Probe respondents as part of the generative design process. In this thesis the separation supports the purpose of research and allows distinguishing insights collection from insights communication for researching the Probes' use in design workshops in particular.

³⁶ Refers to typical design practices for achieving a design outcome over the course of a generative design process, designers' insights exploration, brainstorming, story telling, sketching, etc.

4.3 Programme and Experiments over stages

I applied Binder and Redström's *programme and experiment* approach (2006) to document the thesis research. The *programme* documents the 'knowledge regime' over the course of the research, e.g. the evolution of the core structures of mobile interaction trajectories. It is understood as one (or more) programmatic statement(s) that form(s) a provisional knowledge regime (Binder and Redström, 2006). It represents the current state of knowledge about the topic of research. It can incorporate critique or describe the current view and the research motivation. It can articulate preferred research practices too. A programme is a (quasi) manifesto, which does not necessarily incorporate research questions. The programme acts as a conjecture, which is distinct from a scientific hypothesis. The research's aim is not to objectively prove or refute the programme. Rather it gives direction and helps to design experiments, without claiming that other directions would be less beneficial or less relevant to explore.

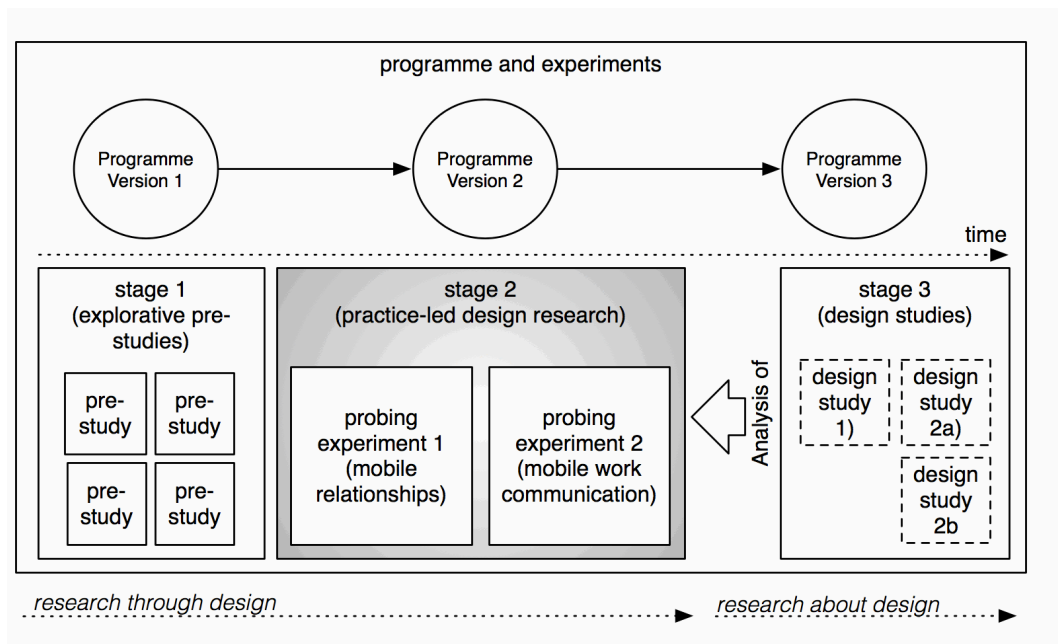


Figure 4.2: Methodology: The programme provides a knowledge regime, which evolved over the course of the research: Documented by programme versions, which inform and influence the probing experiments, but the probing experiments in turn develop the programme further by challenging, critiquing or proving its programmatic statements.

The *programme* for this research explains the evolution of the main and the two secondary programmatic research strands: 1) mobile interaction theory, 2a) the characteristics of the design process with the curated Hankie Probes and other influences on design teams' work, and 2b) the value of fabric-based handmade Probes. For each of these research strands, programmatic statements document

the evolution of the knowledge regime over the course of the three stages of thesis research. A *programme version* summarises the programmatic statements for each stage (see Figure 4.2).

The *experiments* investigate and develop this knowledge regime further. They extend, critique and sharpen the programme. Experiments however, do not refer to scientific or lab-based experiments. Rather, they are understood as design cases and studies. The dialectic evolution of programme and experiments creates a dialogue between new insights and existing programmatic statements. Binder and Redström (2006) require design experiments to challenge, investigate, develop and scrutinise the programme to a satisfactory degree. Research cycles can incorporate a diverse set of methods, which - towards the end of a cycle - may also entail empirical studies to gain objective views about the articulated programme and its outcomes.

I acted as a *methodological bricoleur* (Yee and Bremner, 2011), who uses a rather ad-hoc selection and organisation of research methods, according to the requirements of each stage. Methodological bricolage is a trait of the partial indeterminacy of creativity-led research through design that seeks to innovate and study future artefacts, scenarios or practices. For example, the method of evaluation can only be finalised once the artefact that is to be evaluated is finished. This required an evolving research programme with methodologically adapted experiments. Hence, the methodology, the selection of research topics for the probing experiments and the research questions addressed during stage 3 were defined in the context of the evolving research programme - rather than at the very beginning of the thesis research.

This *programme and experiments* approach, combined with the methodological bricolage, offered a basic frame for tracking and documenting the evolution of the thesis' primary and secondary research strands. It was a helpful framework that provided a basic guidance throughout the three stages of the thesis research. Methodological bricolage allowed adapting to the changing research approach (from *through* to *about* design), to the shifting research perspectives and to the progress and evolution of the thesis' research strands throughout the three stages of research.

4.4 Research stages, programme versions and experiments

4.4.1 Stage one: Explorative pre-studies

This first stage was characterised by a diverse set of explorative pre-studies. The programmatic statements of stage one critiqued the rather static understanding of mobile context and the strong device-centred view within the interaction design community. Table 4.1 lists the programmatic statements for each research strand, which were articulated at the very beginning of this stage.

Programmatic research strand:	Programmatic statements
The value of mobile interaction trajectories for generative design processes	<ul style="list-style-type: none"> • Mobile interaction design approaches have a focus on devices and locations. • Novel theoretical understandings of mobility remain underexploited within user and context focused design research for mobile interaction design
The characteristics of the design process with the curated Hankie Probes	<ul style="list-style-type: none"> • Probing is a user and context focused design research approach for collecting rich accounts and insights
The value of fabric-based handmade Probes in design workshops	<ul style="list-style-type: none"> • User and context focused design resources (Probes, questionnaires, etc.) within mobile interaction design are mainly driven by electronic and paper based formats. • The use of other, non-digital and non-paper based media remains underexploited within user and context focused design research for mobile interaction design

Table 4.1: Programme version 1: Programmatic statements of stage one of thesis research.

Alongside literature studies, I conducted two main pre-studies that explored *mobilities theories* for generative design processes, looking at mobile texting and the everyday use of mobile social network clients. These two pre-studies helped to explore and develop the basic concept of mobile interaction trajectories. Further, these two studies explored alternative materials, such as fabric, as a format for the design of Probes. The use of this material in the subsequent stages of thesis research originated from these pre-studies. In each of the two pre-studies, I engaged with 5 young males aged between 20 and 25, who were students of undergraduate design courses. Figures 4.3 and 4.4 show prototypes of design resources that I developed and used for these pre-studies. Figure 4.3 shows the results working with plasticine sticks as memory aiding devices. Figure 4.4 shows

a predecessor of the Hankie Probe that also shows first influences of a trajectory-based perspective for understanding mobile interaction.



Figure 4.3: The 'quipus': For the first of the two explorative pre-studies I used plasticine sticks. The idea was that respondents could form and deform them by making nudges to the material. Each hand made mark was meant to represent an event of mobile communication. The sticks were used to elicit experience accounts in interviews. The material and the approach did not prove fit for the purpose of studying mobile interactions.

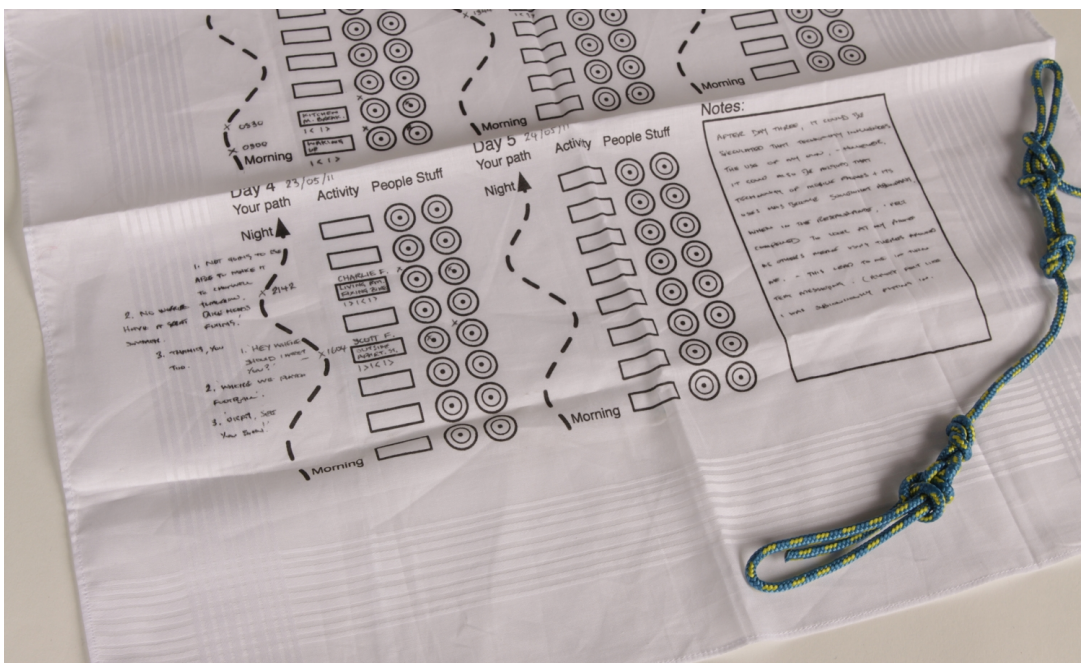


Figure 4.4: Pre-study two: This fabric-based questionnaire was a first experiment exploring this fabric-based format for generative design processes. Respondents were asked to indicate the chronology of their mediated communication. Each entry was used to prompt experience accounts in interviews and was not meant to be self-descriptive. This device is the Hankie Probe's predecessor. The little rope was a playful memory aid. Each knot stood for a single mobile communication.

Alongside these two-pre studies I conducted three additional smaller and loosely related explorative pre-studies that informed the work more indirectly during stage one. In the first of these additional pre-studies, I explored video as a way to convey insights about users and context to designers. The second additional pre-study, called the “the lost notes project”, looked at the design of Probes. It was an autobiographical research study that critiqued the use of digital technologies for researcher-respondent interaction for gathering insights about users and contexts. As a third additional pre-study, and in collaboration with two researchers, I analysed and documented a designer’s process working towards an exhibition. These additional explorative pre-studies are only briefly mentioned here, but are documented by two published papers (Leitner et al. 2013a; Leitner et al. 2013b) and a reflective essay about the “Lost Notes Project”. These documents are added to the appendix (Appendix 4.1, 4.2, 4.3).

4.4.2 Stage two: practice-led design research - The two main probing experiments

The explorative pre-studies of stage one extended and reformulated the programmatic statements for programme version 2, which documents the knowledge regime at this point of the thesis research. The programme version 2 formed in the early phase of stage 2. Hence, Table 4.2 documents the programme version that informed the design and implementation of the two main probing experiments. The programmatic statements at stage two of the thesis research already describe the principles of mobile interaction trajectories. The use of fabric during stage one was promising and motivating, which made me delve deeper here. Therefore, the programme version at the second stage of thesis research shows a range of speculative statements about this fabric format’s value. Further, stage two’s programme version looked at Probes as a way to engage with Probe respondents. The additional focus on the fabric-based Probes’ value for design communication and functions in design workshops only developed during stage two.

Programmatic research strand:	Programmatic statements
The value of mobile interaction trajectories for generative design processes	<ul style="list-style-type: none"> • Mobile technologies make 'matters'³⁷ (things that matter to people) portable. These matters can theoretically be consumed anytime and anywhere. • People experience <i>mobile matters</i> with (and via) their mobile devices. Their experience is subject to the matter itself, e.g. a relationship, but also to the technology with which these matters are consumed, e.g. a text message; a video, a tactile feedback. • <i>Mobile matters</i> take place in <i>mobile context</i>. This is a momentary situation in which people use their phones to be connected to distant others. • In these <i>moments of connectedness</i>, the mobile matters root in a particular place. The contextual aspects of this place influence how, when and where people use their phones. • For the contextualisation of mobile matters, different mobilities (corporeal mobility, virtual mobility, imaginative³⁸ mobility (Urry, 2007)) influence device use in these situations. • Mobile experiences with mobile technologies are therefore located at the intersection of physical, virtual, imaginative mobility. <i>Mobile interaction hubs</i>³⁹ provide favoured conditions for mobile communication and the use of mobile devices.
The characteristics of the design process with the curated Hankie Probes	<ul style="list-style-type: none"> • Probing is a user and context focused design research approach for collecting rich accounts and insights.
Table 4.2 continues on page 98	

³⁷ During stage two, I used the term *mobile matters* to refer to application domains, such as couples' mediated communication or mobile work communication.

³⁸ In this thesis, *imaginative mobility* is understood as "people being reminded of each other by digital means". *Imaginative mobility* is linked to *virtual mobility* and influences awareness about other people and places, without necessarily interacting with each other directly.

³⁹ At this stage, I used the term *mobile interaction hubs* to refer to places that offer favourable conditions for mobile device use. Although the theory of *mobile interaction trajectories* incorporates this idea, the term was dropped, as it seemed to introduce a focus on single locations. This was inconsistent with the theory's understanding of instantaneous temporary mobile communication contexts across a number of locations.

Continues Table 4.2 on page 97	
<p>The value of fabric-based handmade Probes in design workshops</p>	<ul style="list-style-type: none"> • A <i>handmade</i> Probes approach engages people differently. The use of this media may increase engagement and commitment to the design case. • These user focused design resources connect researchers and respondents. The artefacts support the researcher-respondent interaction during insights collection and debriefing interviews. • <i>Handmade</i> design resources for gathering and communicating insights about users and contexts can persist beyond the analysis phase and can be used to communicate insights to designers. They are an appropriate format for design communication. • The design/making of the Probe itself may be an inspiring act itself that informs the design researcher about the context s/he is researching. Designing those objects may become and informative act itself.

Table 4.2: Programme version 2: Programmatic statements of stage two of thesis research.

4.4.2.1 General structure of the two main probing experiments

For this thesis research, I consider the two main probing experiments as one body of work based on the same theoretical and practical principles. I therefore consider the completed and curated Hankie Probes, their use in design workshops and also the design outcomes of these two probing experiments as one research output. I used these sources as one input for the qualitative analysis at stage three of this thesis research. This multi-study reflective methodology is an established strategy within HCI research. For example, Benford's (2009) work on user experience trajectories draws from various projects in order to underpin one theoretical concept.

During stage two, I conducted two probing experiments. These represent the central pillars of this thesis research. Each probing experiment is a design case running through four phases of user centred design work (see Figure 4.5): 1) **Probe design**, 2) **insights collections via Probes**, 3) **curation of the completed Probes by the thesis researcher** (for the subsequent insights presentation in design workshops) and 4) **Probes use in design workshops** with design teams. Phases 1 to 3 are considered as *user and context focused design research* with the Hankie Probes, whereas phase 4 is considered as the *generative design process* with the Hankie Probes.

The first probing experiment looked at couples' mediated communication. I called it the mobile relationships experiment. The aim was to innovate concepts that address couples' everyday communication.

The second experiment looked at work communication. I called it the mobile work communication experiment. The aim of the experiment was to innovate design concepts for communication devices/services addressing contemporary work settings.

The two probing experiments had the following common four phases:

Phase 1: Probes Design: I designed a core Probe concept that was used in both probing experiments, which will be fully elaborated in Chapter 5. I called it the Hankie Probe, as it is based on a fabric format that is similar to a handkerchief. The Probe incorporates the middle range theory of mobile interaction trajectories. The Probes' core attributes were adapted to the probing experiments' settings.

Phase 2 – Insights collection via Probes: In each probing experiment, I worked with five Probe respondents (5 couples [= 10 individuals] and 5 office workers). Chapter 5 will present the completed Probes coming from both main experiments. I introduced respondents to the Probe Packages. They were left with the raw Probes for a week, after which I met them for a semi-structured debriefing interview. During this interview, I talked them through their completed Probes. The interview was semi-structured and lasted for approximately 45 minutes with each participant. The debriefing interviews featured accounts of respondents' daily trajectories, places of mobile phone use and related practices and experiences. Chapter 5 will elaborate on the completed Probes' scope and content. During the interviews, I also asked Probe respondents how they dealt with the Hankie Probe, such as how they kept it, when they used it for recording and how they experienced this way of note taking and reflection.

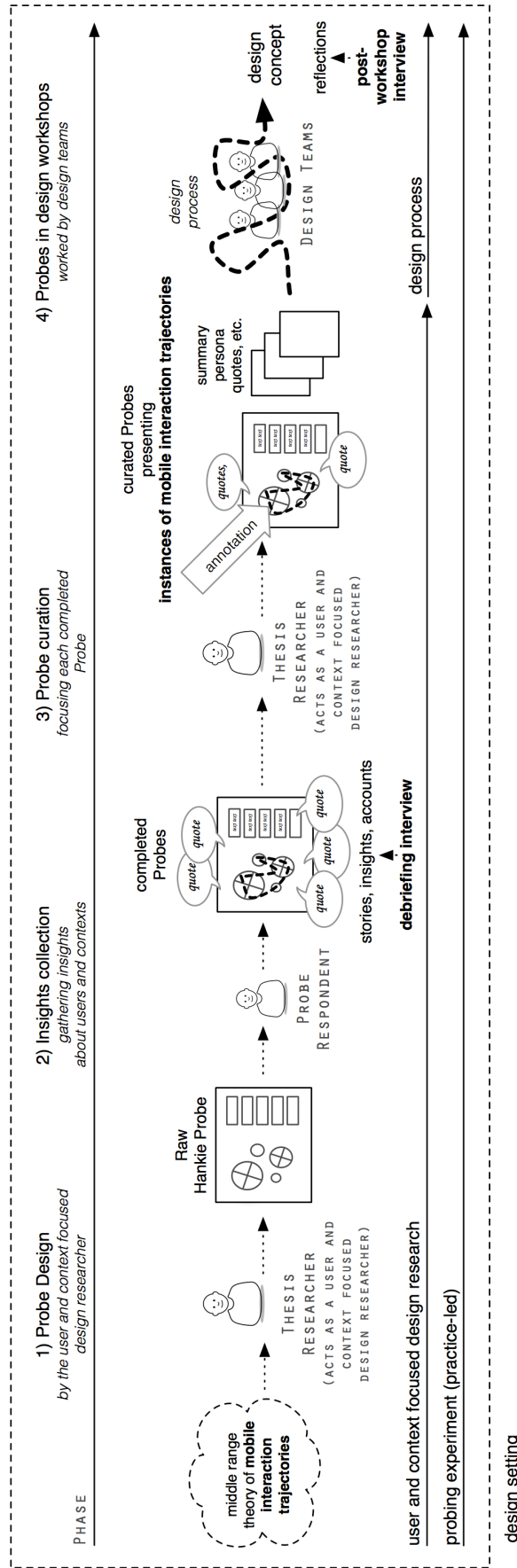


Figure 4.5: General structure of the two main probing experiments.

Phase 3 – Probes curation and preparation for design workshops⁴⁰: I

transcribed and analysed the debriefing interviews and prepared the completed Probes for their use in design workshops. The analysis and preparation was based on: a) the debriefing interview transcripts (see Figure 4.6); b) on the completed space-time diaries (see Figure 4.7) including completed note-taking forms and tags – as they will be introduction over the next sections - and c) on video footage from the debriefing interviews. The qualitative analysis identified up to 7 thematic clusters for each Probe. One theme was selected by the thesis research as a main narrative for the Probes' presentation in design workshops. The selected themes and the curation criteria for each Probe will be elaborated in Chapter 5. A discussion of the curation process' advantages and risks is provided in *Chapter 9 Conclusion*.

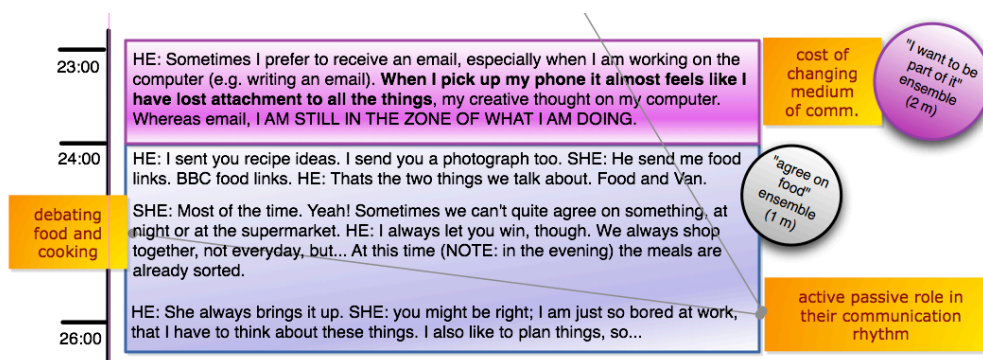


Figure 4.6: Example of thematic analysis of debriefing interviews (excerpt from couple MRS4' debriefing interview). Pink and blue boxes indicate different identified themes. Orange boxes represent the thesis researcher's notes.

The results of this activity were so called *instances of mobile interaction trajectories*. They express a real-life example of mobile interaction trajectories. Each is a focused narrative presenting a selected theme taken from the completed Probes and debriefing interviews. This selection was opportunistic with the aim to introduce interesting and expressive instances of mobile interaction trajectories. However, the aim was to balance the narratives and themes for the 5 curated

⁴⁰ Curation was necessary because of two reasons: **First**, it was necessary because of the rather short design workshops that the Probes were going to be used in. Presenting the completed Probes in an unprepared way would have left them incomprehensible. The short period of time would not have been enough for exploring all the base materials, including debriefing interviews, etc. The artefacts needed explanation and annotation to be understood in these rather short workshops. **Second**, the curation allowed for the presentation of the Probes as *instances of mobile interaction trajectories*. The curation process was a chance to focus each completed Probe through the lens of this middle range theory. The Probe presentation in design workshops therefore aimed to highlight aspects of the theory. The curated Probes highlighted the theory's trajectory-based perspective as well as its focus on practices and experiences of changing states of connectedness, chronologies of mediated communication and mobile communication routines. By presenting curated Probes, I exposed the design teams to the theory's particularities.

Probes and to highlight the theoretical perspective of mobile interaction trajectories for the design workshops. Further, the design workshops were expected to be short, and designers needed to understand the completed Probes in a rather limited period of time. Hence, the completed Probes needed to be presented along with additional information, which explained the artefact and the instance in a usable way. This approach also aimed to standardise the Probes' presentation for different design workshops. The selected instances of mobile interaction trajectories are presented as part of the design resource portfolio in Chapter 5.

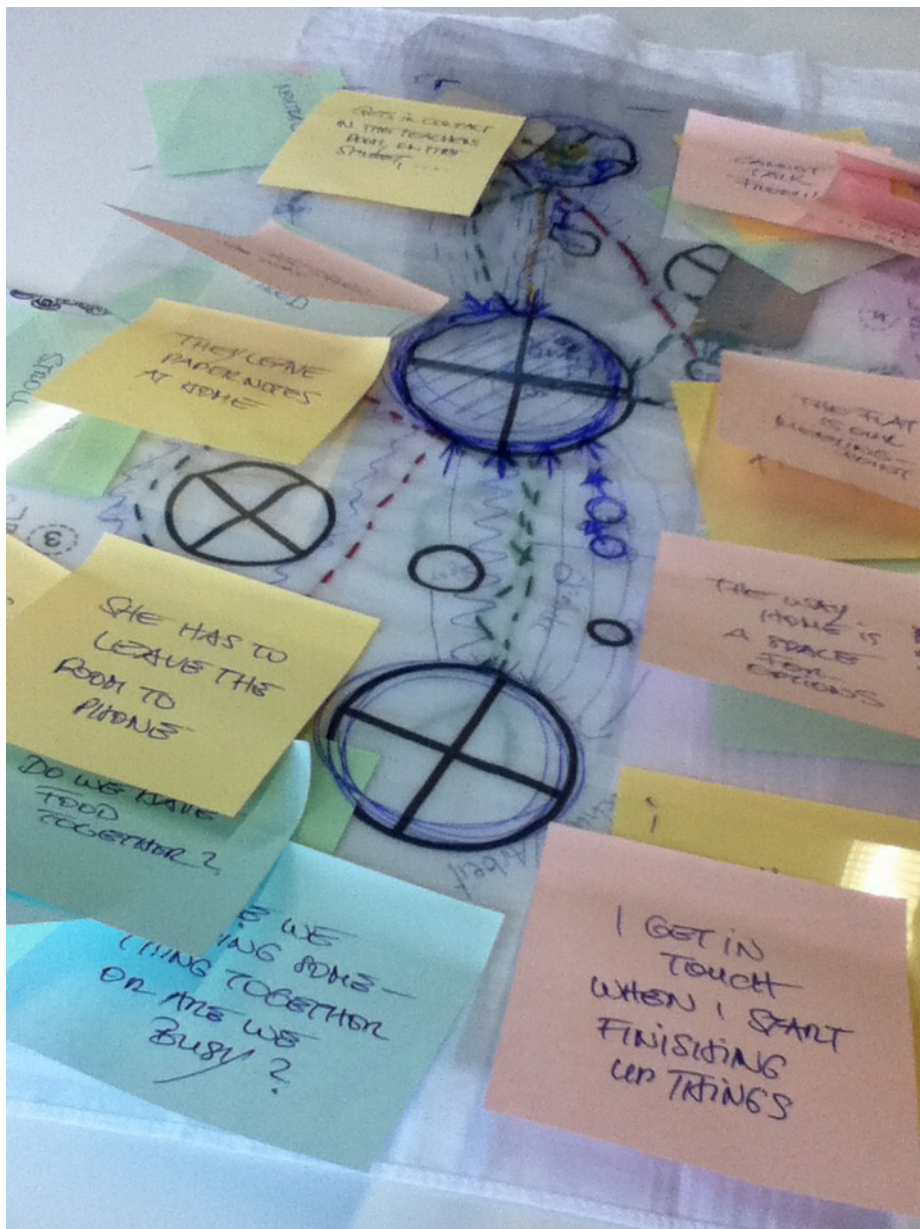


Figure 4.7: Example of space-time diary analysis. I analysed the space-time diaries labelling and clustering relevant aspects with sticky notes. When necessary I used overhead transparencies on top of the space-time diaries to highlight details on the fabric. This allowed for the interrelating of thematic clusters from the debriefing interviews with particularities of the completed space-time diaries.

Each instance of mobile interaction trajectories was selected and introduced by the thesis researcher and expressed via a curated Hankie Probe, which comprised the following items (also see Figure 4.8):

- (1) the completed space-time diary on the fabric cloth, which also contained completed forms about the context of communication.
- (2) a visually annotated version of the space-time diary highlighting the relevant parts for the instance of mobile interaction trajectories
- (3) a short introduction/summary of the presented instance (text format)
- (4) a short description of the Probe respondent (text format)
- (5) selected quotes taken from the debriefing interview (text format)
- (6) an abstracted and theoretical version of the instance of mobile interaction trajectories (as a visual figure)

These additional materials were printed on cardboard and added to the Probe (see Figure 4.8). The curated Probes of probing experiment one and two are presented in Chapter 5.

Phase 4 - Design workshops: During stage two of this thesis research, 28 designers worked with the curated Probes in design workshops. Design workshops were held in medium sized rooms with a central worktable and with space for maximum 6 designers. During the workshops, designers were sat around the table. I used a projector for an introduction. I provided sketching paper, pens and pencils that designers could use for their work. Designers did not use any other materials or sources to inform their work, e.g. they did not browse the internet or consult other sources of information. The instances of mobile interaction trajectories were presented to design teams via the curated Probes. I conducted 8 generative design workshops with 28 designers in total. In each workshop, 3 to 5 designers worked the curated Probes. Each workshop lasted between 60 and 90 minutes. The particularities of these design workshops; the participating designers and their background will be explained in the next sections. The design outcomes of these workshops as well as an analysis of the design processes are presented in Chapter 6, 7 and 8 of this text.

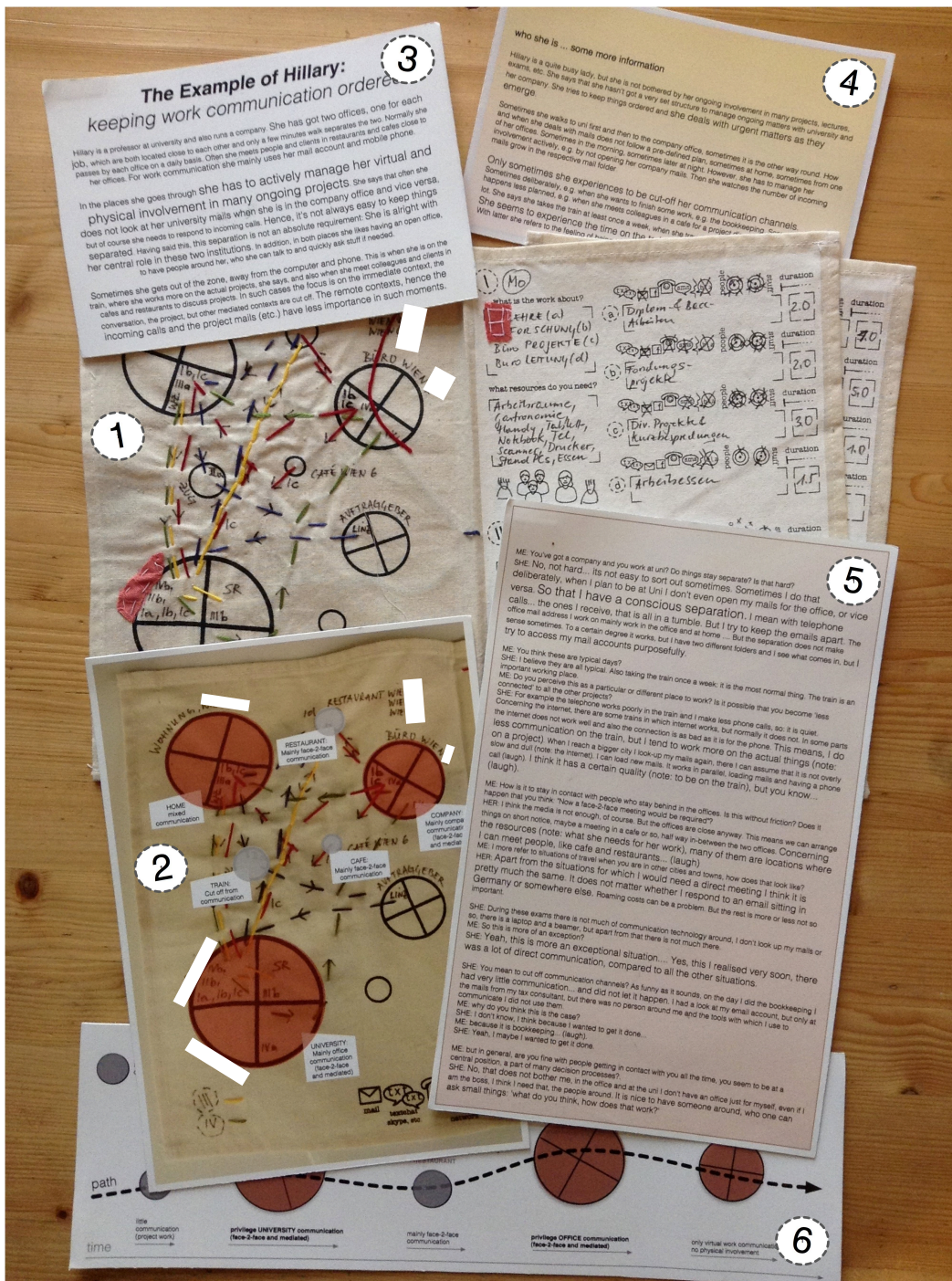


Figure 4.8: Curated Probe introducing an instance of mobile interaction trajectories. Printed cards provide summaries, quotes and a visual annotation of the space-time diary (numbers refer to the list on the previous page).

4.4.2.2 Probing experiment one: Designs for mobile relationships (MRS)

Focus and Aim: This experiment's **practice-led design aim** was to innovate design concepts that address couples' everyday mediated communication. The **thesis research aim** was to understand mobile interaction trajectories and the Hankie Probe's value as part of the probing experiment, but in particular as part of

the design teams' generative design processes during the design workshops. The study looked at couples' mobile communication. It inspected their mediated communication in the context of physical mobility and how they experience their virtual means of staying in touch. Based on such insights, 4 design teams were asked to design new products and services for these users and their contexts (see Figure 4.9 explaining probing experiment one's four phases).

Topic selection: Couples seemed to be a good topic to study and to design for mobile interaction trajectories. The topic offered a clear scope for this probing experiment. First, couples guarantee a minimum amount of mediated communication. Second, couples are 2 people meeting each other on a regular basis (face-to-face) and are likely to stay connected via media when separated. This interplay between immediate and mediated communication offered a good basis for studying their mediated communication via the middle range theory of mobile interaction trajectories. Third, couples' communication is a topic that designers participating in the design workshops were likely to be familiar with.

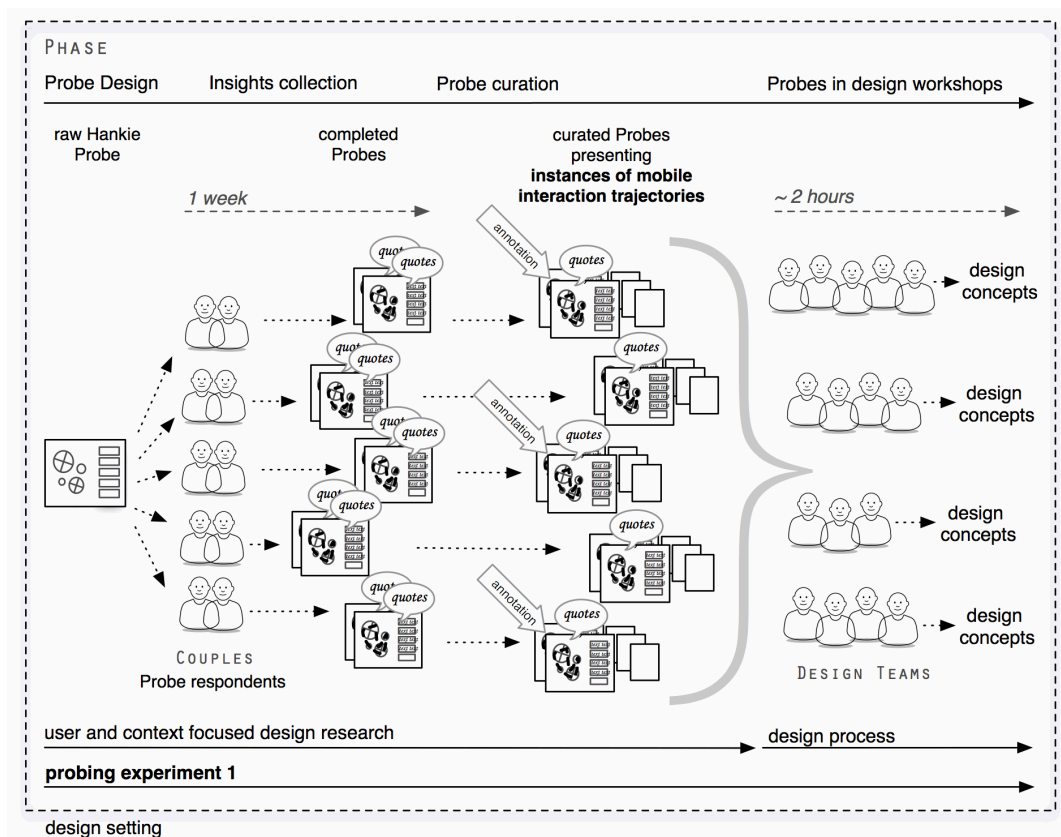


Figure 4.9: The four phases of Probing experiment one: 5 couples completed a Probe each. Each respondent was interviewed. Completed Probes were then curated by the thesis researcher. The 5 curated Probes representing **instances of mobile interaction trajectories** fed 4 workshops with 16 designers in total.

Phase 1 - Probe design: Figure 4.10 shows the Probe design that was used for the first probing experiment. The left side shows the key entity: the space-time diary. Respondents were asked to indicate the places they go, their daily paths as well as to take notes about when and where they use their mobile device to stay in touch with each other. The Hankie Probe also offered forms to take notes about the contextual situations in which they used their mobile devices. The space-time diary can be stitched or drawn on. The respondents were given materials for both types of recording. The aim of this Probe design was to create a visually attractive and personalised space-time diary that can be used as a baseline to discuss respondents' practices and experiences with communication technologies. Together with respondents' quotes, the space-time diary was thought to be a suitable device for generative design workshops⁴¹.



Figure 4.10: Hankie Probe Package to study mobile relationships: The main entity is the fabric cloth in form of a handkerchief. Respondents are asked to record their daily trajectories stitching or drawing them on the space-time diary. The circles printed onto the cloth represent places. Participants are also asked to take notes about their communications with each other. They indicate the place of communication on the space-time diary and take notes about the context of these situations. The forms on the right side of the Hankie space allowed respondents to do so.

⁴¹ A more detailed description of and rationale for the Hankie Probe is provided in Chapter 5.

As supplement to these core aspects (space-time diary and note-taking forms), I added large and small tags to the Probe package. The large ones asked respondents to remember and report one positive and one negative situation in their past that described their communication as a couple. The small tags asked participants to record moments in which they were thinking about each other (but without directly communicating with each other). The smaller tags were to be attached to the Probe package.

Phase 2 - Insights collection: I worked with 5 couples (See Table 4.3 for couples' backgrounds and characteristics). They were academics in their late twenties/early thirties. Two couples lived in Austria and three in the UK. Three couples shared a flat; two of them lived in the same town but did not live together in one apartment. The couples recorded their daily trajectories (one Probe package for each person) and took contextual notes about the situations in which they used to communicate with each other, e.g. what they were doing at this point, what their social context was, etc. They were free to stitch or draw their space-time diaries. They recorded for one week and were asked to record their trajectories and communications on one space-time diary, but could start another space-time diary if they needed to. The Probe package contained 3 space-time diaries/3 handkerchiefs in total. The results are individual handmade space-time diaries together with contextual notes. Juxtaposing their responses their space-time diaries showed when and where they stayed in touch with each other via communication technologies. The debriefing interview prompted further practice and experience accounts. My initially preferred option was to interview the couples separately to have enough time with each person. In addition, I assumed this would allow each person to speak more freely. However, I interviewed only two couples separately, but three of them together. This was due to couples' time constraints and limited the amount of time each person could talk about his/her personal space-time diary. However, the situation led to interesting conversations and insights that separate debriefing interviews could not have exposed. In retrospect, both interview approaches seemed suitable for the purpose of this practice-led probing experiment.

The debriefing interview focused on the space-time diary. Hence, I asked Probe respondents to explain their daily trajectories to me. I then asked them to talk about the moments in which they used their mobile devices (hence, their moments of connectedness alongside their personal trajectories), also referring to their contextual notes and the way they had indicated to do so on the space-time diary.

These discussions led to insights about respondents' practices and experiences of mediated communication, about trajectories and their everyday contexts and places. And finally, we examined the additional materials if the completed Probes had any, i.e. the card tags included in the Probe packages of the first experiment.

ID	age	profession	flat
MRS1a, MRS1b	28, 30	both teachers of under-graduate pupils	shared flat
MRS2a, MRS2b	30, 32	student and bar tender, student and language lecturer	separate flats
MRS3a, MRS3b	27, 28	post graduate researcher, post graduate researcher	separate flats
MRS4a, MRS4b	29, 32	employee in marketing, manager machinery,	shared flat
MRS5a, MRS5b	32, 35	lawyer, employee car industry,	shared flat

Table 4.3: Probe respondents participating in the Mobile Relationship experiment

The interviews were recorded on video. The design resource portfolio in Chapter 5 explains the raw, completed and curated Probes' elements that resulted from these activities.

Notes on selection of Probe respondents: I selected the couples based on a short pre-interview. The aim was to balance the respondents' characteristics and to collect five expressive instances of mobile interaction trajectories. Therefore, I selected couples with communication characteristics that conformed to the perspective of mobile interaction trajectories. Overall, I contacted 8 couples and selected the 5 listed in Table 4.3, based on the following criteria: First, the couples' "locations": I wanted to work with a minimum of 3 couples that share a flat. Couples were to live in the same town. This eased the administrative part of research, but also guaranteed that they saw each other in person. It allowed studying mediated communication without neglecting its relation to immediate face-to-face communication.

Second, their *mediated communication*: I selected couples who indicated use of mobile communication media to stay in touch on a daily basis (at least with text messages and calls). This guaranteed that couples' trajectories are *tethered* to each other via communication media. Third, their "routines": I wanted them to be in professional jobs. This assured that they separated in the morning to go to work on

a regular basis, which means to be on an individual trajectory and to use their phones to stay in touch. A regular (professional) work life also involved a certain level of repetition in terms of mediated communication.

Third, the Probe *respondent's demographics*: I selected a target group that I could emphasise with (to a certain degree), in terms of professional background and age. This helped to select appropriate couples, as I could empathise with their mobile patterns and communication routines. Furthermore, this seemed to provide an empathic context for working with the completed and curated Probes too⁴². The selection of Probe respondents was also influenced by the context in which this research was conducted: The thesis research was not carried out within a particular project that provided access to research subjects. Hence, I had to work with target groups that I had access to via means of social media, private and professional networks.

Phase 3 - Probe curation: I analysed the completed space-time diaries and the debriefing interviews. For each completed Probe, I clustered the emerging themes from the debriefing interviews. I curated the Probes and prepared the supportive materials. The curation criteria for each Probe will be explained in Chapter 5. Generally, I aimed at a balanced distribution of instances of mobile interaction trajectories across the curated Probes. The presented instances differed from each other in their narrative, highlighting different instances of mobile interaction trajectories. The design resource portfolio in Chapter 5 gives an overview of emerging themes for each Probe and also shows the curated Probes as they were presented to the design teams.

Phase 4 - Design workshops with instances of mobile interaction

trajectories: I conducted 4 design workshops at two HCI research hubs based in central Europe. At the beginning of each workshop, I gave a short introduction to the curated Hankie Probe and to the instances of mobile interaction trajectories. I explained the space-time diary and the contextual notes. I briefly explained how the Probes were collected. I was present during the workshops to facilitate the process.

⁴² Note on *insights collection with the Hankie Probes*: in this thesis research it was not the aim to use Probes as a way to empathise and familiarise with a target group that is alien to researchers and designers, or with target groups that are hard to reach or access. Rather, Probe use was a way to develop a theory through a practice-led approach and to materialise a theory in a design setting by collecting and communicating expressive instances via these user and context focused design resources. In this sense, the use of Probes deviates from the Gaver et. al's probing agenda (1999). In this sense, the use of the Hankie Probe is more similar to approaches like *Information probes* (Crabtree et. al, 2003) and *Context mapping* (Visser et al., 2005) – this discussion will be returned to in Chapter 5.

ID & Session	Background	Years *	Probe
1A	HCI, computer supported collaborative work	10+	MRS2
2A	industrial design, interaction design	5	MRS1
3A	interaction design	7	MRS3
4A	interaction design, media information systems	5	MRS4
5A	interaction design, engineering	5	MRS5
1B	interaction design, psychology	4	MRS1
2B	HCI, Anthropology	2.5	MRS5
3B	media informatics, HCI	2	MRS3
4B	HCI, Cognitive Science, Robotics	1	MRS4
1C	interaction design, journalism, software engineering	10+	MRS3
2C	HCI, media information system, web design	3	MRS4
3C	HCI, psychology	1	MRS5
1D	HCI, psychology	4	MRS4
2D	informatics, linguistics	1	MRS5
3D	cognitive science	1	MRS1
4D	interaction design, media information systems	4	MRS3

*Table 4.4: Participating designers in design workshops of experiment one. The last column describes which designer used which Probe. * years in professional work (HCI experience excluding years in education).*

Each design workshop was attended by three to five designers (16 designers in total, see Table 4.4). I asked each designer to select one instance of a mobile interaction trajectories and to come up with a design response within 40-60 minutes. The designers were expected to produce a conceptual sketch and/or description of their idea. They were told that the aim was to enhance, disrupt or change the couple's practice or experience that the instance described. After one hour each designer presented his/her ideas to the group. In this presentation, the designers were asked to articulate their design rationale and reflect on the parts of the curated Probe they thought had inspired them. During the post-workshop-interview designers were asked to reflect on the curated Probe. I firstly wanted to understand how they perceived working with the presented instances of mobile interaction trajectories. The second focus concerned how designers perceived the space-time diaries handmade aspects. The design workshops and the post-

workshop-interview were video taped. At the end of each workshop, I collected the designer's drawing sheets and notes.

Notes on selection of designers: The 5 design workshops were conducted at two international research hubs, both based in Vienna, Austria. Both organisations are active in the international HCI and interaction design community. They conduct and publish their work in an international research context. Running the workshops at these places gave me access to a range of backgrounds and skills that are typical for contemporary HCI design and research - ranging from psychology to product design. At the institutions, invitations were sent out and interested interaction designers subscribed for defined time slots.

4.4.2.3 Probing experiment two: Designs for mobile work communication (MWC)

Focus and aim: This experiment's **practice-led design aim** was to introduce design concepts that address mobile work communication. The **thesis research aim** was to understand mobile interaction trajectories and the Hankie Probes' value as part of this probing experiment, but in particular its value for the designers processes working with this user and context focused design resource. The Hankie Probes aimed to collect fruitful examples of Probe respondents' practices and experiences describing their mediated work communication via mobile interaction trajectories. The aim was to inspire design workshops based on professionals' mediated communication practices and experiences with colleagues and clients 4.11 explains probing experiment two's four phases.

Topic selection: The theme of mobile work was interesting for several reasons. First, it has received considerable attention within HCI over the last decade. Existing studies in the literature informed the probing experiment, e.g. Wiberg and Ljungberg's (1999) study on mobile work communication. Further, mobile work communication changed dramatically due to the emergence of mobile devices, e.g. email, text messages, and other forms of (mobile) social network technologies. This seemed to be an interesting focus for the purposes of my thesis research.

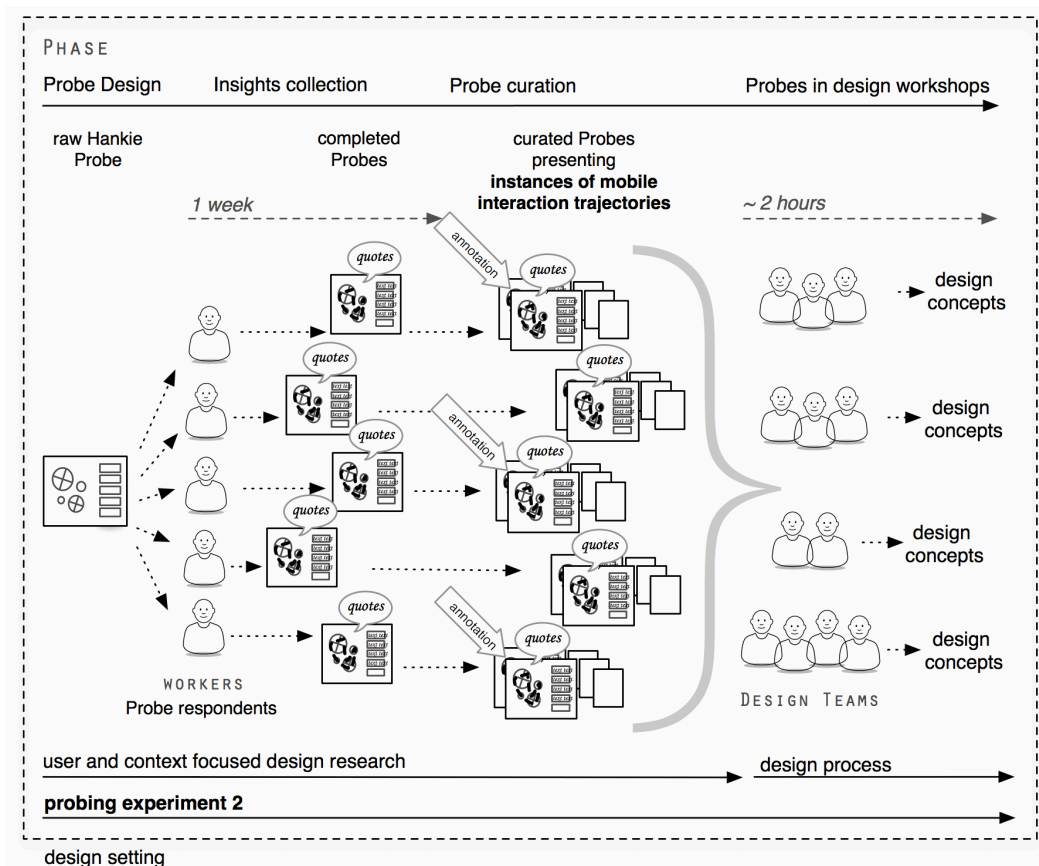


Figure 4.11: The four phases of Probing experiment two: 5 office workers completed a Probe each. Each respondent was interviewed. Completed Probes were then curated by the thesis researcher. The 5 curated Probes representing instances of mobile interaction trajectories fed 4 design workshops with 12 designers in total.

Phase 1 – Probe Design: The Probe design was adapted to the experiment’s characteristics, without changing the Hankie Probe’s core concept, compared to the first probing experiment. The raw Probe is shown in Figure 4.12. Again the space-time diary was the key entity. Similar to the first experiment, Probe respondents were asked to indicate and take notes about their mobile device use (when/where/contextual aspects). The forms for taking notes about the context of communication were re-designed to fit the topic of work communication. The particularities of this Probe design are presented in the design resource portfolio in Chapter 5. For this study, I dropped the use of tags. The purpose of tags did not really fit the concept of mobile work communication; nor had the tags returned much usable feedback during the first study. Further, these add-ons had made the Probe rather impractical to transport, which was one reason why respondents did not carry the Probe with them very often. The Probe’s fabric format stayed the same, although I improved the Probe design in this respect. I used a different fabric with a more natural look and feel (compared to the handkerchief’s white and polished look of the first experiment’s Probe design). During the first experiment,

some participants reported that writing on the fabric was cumbersome. For the second probing experiment I coated the fabric with a thick white colour for textiles to improve the device's writeability. This generated a sleeker surface for writing on the fabric (See Figure 4.12).

Phase 2 - Insights collection: For Probe completion, I worked with 5 professionals aged 25 to 55. Four were located in Austria, and one of them in the UK. All of them worked at one or more companies/offices and used one or more communication technologies to manage their work communication. Each participant was introduced to the Probe package individually. They recorded their trajectories and work communication for one week on one space-time diary. I conducted a semi-structured debriefing interview when I collected the completed Probe. These interviews were audio and video taped.



Figure 4.12: The Hankie Probe for the study of mobile work communication: The Probe package shows the space-time diary printed onto a fabric cloth. Respondents sewed, stitched and drew their trajectories onto the space-time diary. The Probe participants were asked to take notes about the contexts in which they use their mobile phones for work purposes.

Similar to experiment one, the debriefing interview initially focused on the space-time diary, asking respondents to explain their daily trajectories. We then talked about the moments of connectedness in which they used their mobile devices, when and how respondents do so. We referred to the contextual notes if needed. The debriefing interview prompted insights about respondents' practices and experiences, about places and their trajectories.

ID	age	profession	Work places
MWC1	45	radio and art journalist	museum, radio station, private office
MWC2	52	professor at university and company owner	university, company office, customer visits
MWC3	33	team-leader service industry	office, customer visits
MWC4	55	company owner, research and consulting	office, home office
MWC5	25	employee construction industry	office, on site visits

Table 4.5: Probe respondents of the Mobile Work Communication experiment.

Notes on selection of respondents: Probe respondents listed in Table 4.5 were pre-interviewed to check their type and amount of (mobile) work communication and their work-place situation. I screened 7 potential participants and selected the 5 listed in Table 4.5. I applied two criteria. First, Probe respondents needed to use one or more communication media for their work (email, phone, social network clients, etc.). Second, they needed a job that required them to physically move away from the desk, e.g. for client meetings, offsite visits or lectures (etc.). If respondents met these criteria I asked them to join the study. The actual type of work was of minor relevance for respondent selection.

The Probe respondent's demographics: Similar to experiment one, I selected a target group that I could familiarise with. This allowed me to work with professionals, who I could empathise with, in terms of their mobile patterns and communication routines. It also provided an empathic context for working with the completed and curated Probes. The selection of Probe respondents was also influenced by the context of the thesis research, which was not conducted for or within a particular project that provided access to research subjects. Therefore, I worked with Probe respondents that I had access to via means of social media, private and professional networks⁴³.

Phase 3 – Probe curation: I analysed the completed Probes in combination with the themes and insights from debriefing interviews. I prepared the completed Probes for the design workshops and introduced an instance of a mobile

⁴³ Note on *insights collection* with the Hankie Probe: As discussed for probing experiment one, I used Probes in a similar way to *Information Probes* (Crabtree et al. 2003) or *Context Mapping* (Visser et al., 2005). Probes were a way to develop and research a theoretical perspective, and to collect and communicate expressive real-life instances, rather than to access alien and remote contexts – as in Gaver et. al's (1999) original probing agenda.

interaction trajectories for each completed Probe. For each instance, I selected a theme that emerged from the completed space-time diary and debriefing interview. The design resource portfolio in Chapter 5 presents an overview of the completed Probes and the presented instances, as well as the curation criteria.

Phase 4 – Design workshops with instances of mobile interaction

trajectories: The instances of mobile interaction trajectories were used in four design workshops, each of which was attended by 2 to 4 designers (see Table 4.6) – 12 designers in total. I briefly presented the instances of mobile interaction trajectories via the curated Probes and the design aim of the probing experiment. In this experiment the designers were asked to work as a team. I selected two curated Probes for each team. They were asked to work with the two instances of mobile interaction trajectories one after the other. Their task was to enhance, disrupt or change the workers' practice and experience that the instance of mobile interaction trajectories described. I was present during the workshops to facilitate the process. At the end of each design workshop, a post-interview was conducted with the team to reflect on the design process and in particular on the Probes' handmade format. This post-workshop-interview was semi-structured asking the teams to a) reflect on their experience working with the instances of mobile interaction trajectories and in particular about the idea of the space-time diary and b) about the Probe's handmade parts. The design workshops and post-design interviews were video taped.

Notes on selection of designers as participants: I worked with an internationally operating research hub based in Sweden. The motivation to work with this institution was its strong background in interaction design and HCI. Consequently, I worked with groups of interaction designers with backgrounds and skills that are typical for contemporary interaction design research. At the institution, the groups for each workshops were arranged according to the availability of the participants. Designers could appoint pre-defined slots. This led to a random, but overall balanced distribution of typical interaction design skills across the groups (See Table 4.6).

ID & Session	Background	Years in interaction design	Probe
1E	industrial design, computer animation, HCI	3	MWC1, MWC5
2E	interaction design, engineering	4	
3E	HCI, mobile interaction design	2	
1F	computer science, ubicomp, HCI	11	MWC2, MWC3
2F	interaction design, cognitive Science	1.5	
3F	interaction design, cognitive Science	5	
1G	interaction design	4.5	MWC4, MWC5
2G	industrial and interaction design	5	
1H	interaction design	3	MWC1, MWC2
2H	electrical engineering, HCI	2	
3H	HCI	13	
4H	HCI, philosophy	2	

Table 4.6: Participating designers in design sessions for mobile work communication

4.4.3 Stage three: Design Studies - Empirical analysis of probing experiments in Stage two

The aim of **stage three** was to analyse the design workshops conducted at stage two of the thesis research (research *about* design). The qualitative analysis is based on the design outcomes (design concepts), the transcripts of the design workshops (their design processes), and the post-design interviews (See Figure 4.13). This research about design aimed to strengthen insights and to gain knowledge. The results of these design studies aimed to increase the extensibility of this thesis research.

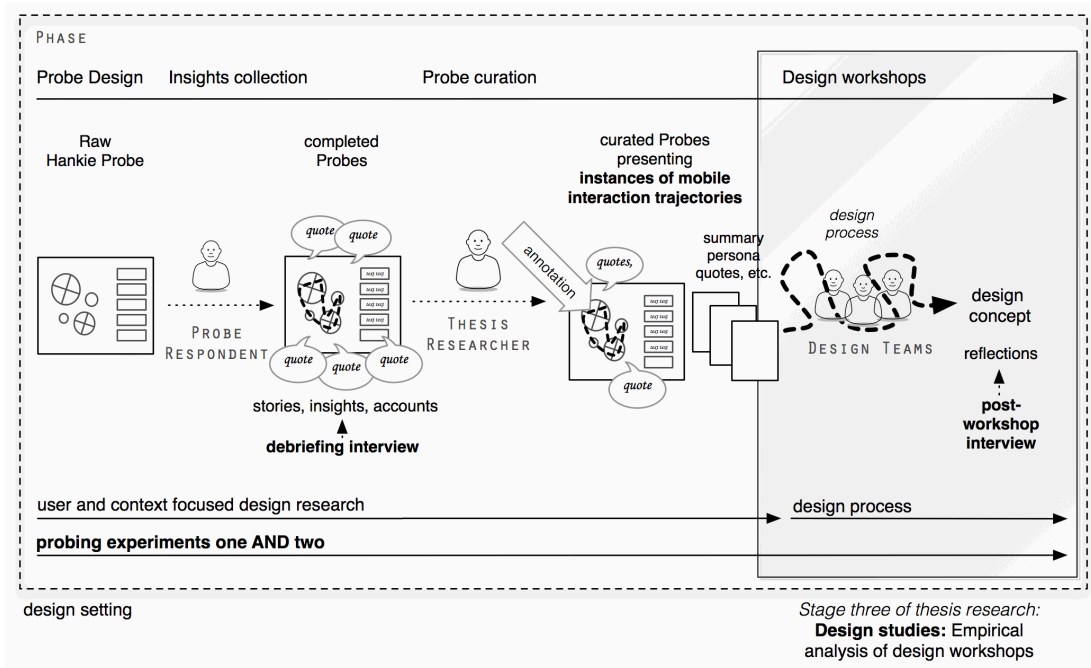


Figure 4.13: Stage 3 of thesis research: Research about design. Empirical analysis of the design workshops with instances of mobile interaction trajectories presented via curated Probes.

I conducted three *design studies* with a different analytical focus. This threefold analysis was in line with the primary and two secondary programmatic research strands⁴⁴. First, I looked at mobile interaction trajectories' value for generative mobile interaction design processes. Secondly, I analysed the curated Probes' role during design processes and identified other influences on the design teams' work. Thirdly, the aim was to research the Hankie Probes' value as a handmade artefact.

The program version at this stage was an elaborated set of statements (Table 4.7). It represents the knowledge regime at the beginning of stage 3 of thesis research. Hence, at this point the programmatic statements and terminology still differed from the final definition of the middle range theory of mobile interaction trajectories presented in Chapter 3. The understanding of mobile interaction trajectories had become more intricate based on insights gathered during stage two. Further, programme version 3 comprised a broader understanding of Probes as user and context focused *design* resources, rather than an insights collection instrument. The programmatic statements especially highlight the resource's theoretical functions for generative design process. In addition, the programme had drifted

⁴⁴ Primary research strand: The value of mobile interaction trajectories for generative design processes; Secondary research strands 2a) The characteristics of the design process with the curated Hankie Probes and other influences on design teams' processes and 2b) The value of fabric-based handmade Probes in design workshops

towards understanding the Hankie Probes as a handmade artefact for design work. Generally speaking, the programme was now looking more closely at the Hankie Probes as part of design processes, rather than its abilities to interact with respondents for collecting insights.

Programmatic research strand:	Programmatic statements
The value of mobile interaction trajectories for generative design processes	<ul style="list-style-type: none"> • Through mobile technologies the interaction with other people becomes <i>portable</i>, in the sense that they can theoretically be contacted anywhere, anytime. • Corporeal movement alongside individual <i>trajectories</i> across different places of everyday life orders and frames mobile connectedness • The characteristics of the <i>locative context</i> is a relevant factor for mobile connectedness, e.g. social, activity, product and physical context. • <i>Mediated contexts</i> describe people's virtual connections to distant people and places • Locative context and mediated contexts are of similar importance and form a <i>blended context</i>. • People <i>experience distant others</i> via their mobile devices. • <i>Moments of connectedness</i> are temporary situations in which people are connected to distant others and distant places via media.
	<ul style="list-style-type: none"> • <i>Periods of connectedness</i> describe the chronology of device use and moments of connectedness over a period of time and alongside individual and personal trajectories • Mobile experience is subject to the <i>chronology and locality</i> in which mobile connectedness takes place, influenced by the <i>media and devices</i>, e.g. a text message: a video, a tactile feedback.
The characteristics of the design process with the curated Hankie Probes	<ul style="list-style-type: none"> • Probing is a design focused approach to collect rich accounts and insights from user contexts which are communicated to design teams. • Probes respond to the theoretical perspective on users and contexts, informed by theories for mobile interaction design. • Probes represent users and contexts using different media and formats. The Probe determines users' and contexts' appearance in design settings, offering particular qualities depending on its design.. • Completed and curated Probes can help structure insights about users and contexts and point at interesting scopes of insights. • Probing supports researchers and designers in making design choices during the generative design process.

Table 4.7 continues on page 119

Continues Table 4.7 on page 118

<p>The value of fabric-based handmade Probes in design workshops</p>	<ul style="list-style-type: none"> • <i>Handmade</i> Probes persist beyond the analysis phase and can be used to communicate findings and insights to designers directly. • <i>Handmade</i> Probes are an appropriate channel for insights communication in design settings. • The use of techniques like sewing and stitching, allows Probe respondents to 'weave' their experience into the artefacts in an individual and personal way. The personalised artefacts can represent the Probe respondent and their context in design settings. • <i>Handmade</i> Probes represent user and context in design settings in a subjective way. The personalised Probes require designers to subjectively interpret the data. • <i>Handmade</i> Probes are interesting and appealing artefacts, which Probe respondents and designers like to work with. • The use of <i>handmade</i> Probes demands more time for completion and interpretation. The interaction with the fabric-based Probe can introduce a sensual way of interaction with insights.
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Table 4.7: Programmatic statements of stage three of thesis research.

In design research the term *design studies* is often used to describe *research about design*. Design studies analyse design work and processes to understand the creation of design solutions. An analysis method that is often used in design studies is *protocol analysis* (Ericsson and Simon, 1993). The approach has a profound tradition in design studies (Cross et al. 1997). For the qualitative analysis of design workshops, I used this approach. In design studies, protocol analysis is often based on transcripts of verbal reports of a design process of one or more designers working on a design problem over time. Therefore, design workshops are (video) taped. Designers are prompted to 'speak aloud'. Data about the design process is extended by further evidence that documents the design process, like notes and sketches. Transcripts are coded on the level of *speech units*. Speech units are interlinked to show interdependencies, to document designers' reasoning and the transforming states of the design situation that moves towards a design solution. Coding schemes can be pre-defined or developed during the coding process – depending on the study's aim. Figure 4.14 shows an example of coded speech units, taken from analysis work conducted in this thesis research.

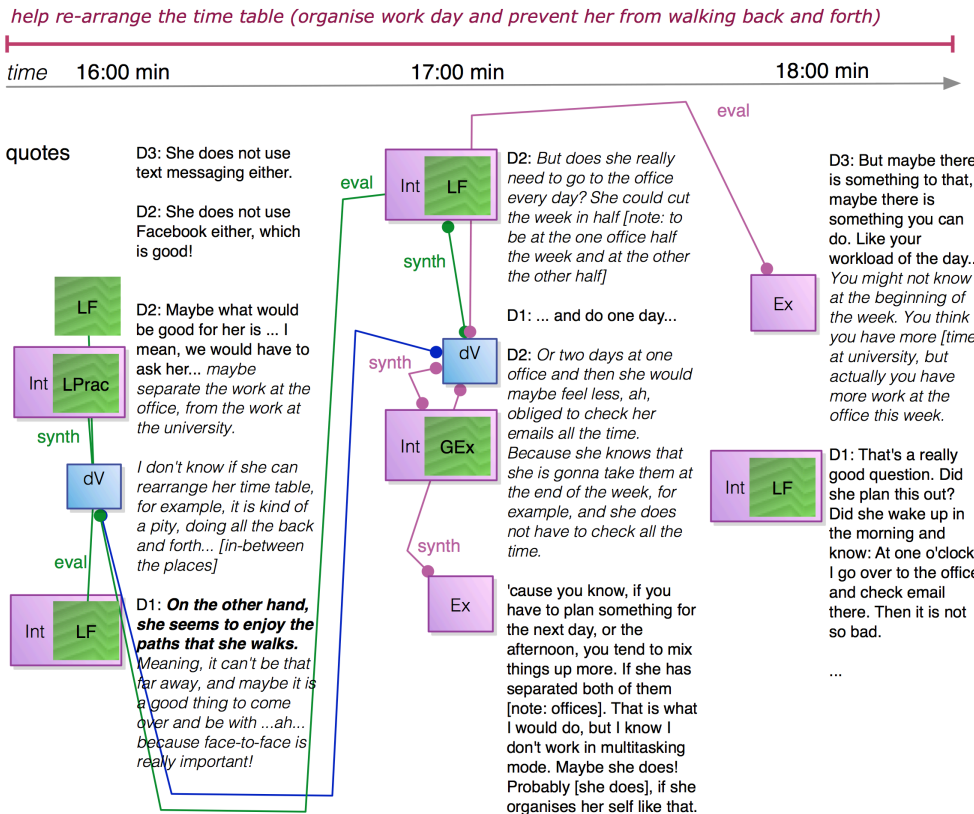


Figure 4.14: Example from design workshop transcript. Speech units are coded with colored labels that represent coding schemes. Speech units are interlinked to show interdependencies. More details will be presented in Chapters 6 and 7.

I chose this method as numerous design studies have shown it to be an appropriate, accepted and well-described method for the analysis of design processes. The analysis addressed the thesis' primary and two secondary research strands and used the following data sources:

Primary research strand: *The value of mobile interaction trajectories for generative design processes:* First, the qualitative analysis looked at the design team's processes in order to understand how they worked with instances of mobile interaction trajectories. The aim was to identify those aspects of mobile interaction trajectories that designers used to inspire and inform their work. The analysis also drew from researching the design outcomes' characteristics. The particular method of analysis and the findings are reported in Chapter 6.

Research strand 2a: *Characteristics of the design process with the curated Hankie Probes and other influences on the design teams' processes:* The second strand of analysis looked at the Probes' role in the design teams' processes. The method of analysis and findings are reported in Chapter 7. The aim was to identify how design teams worked with the Hankie Probes to understand their design

processes with this user and context focused design resource better. The analysis also looked for other influences on the design process that designers used for their creative work. The results embed the findings about mobile interaction trajectories within a broader picture, but also contribute knowledge to the theoretical understanding of generative design processes with Probes.

Research strand 2b: *The value of fabric-based handmade Probes in design workshops:* The third analytical lens looked at the value of the Hankie Probe's fabric format. The method of analysis and the results are described in Chapter 8. The aim was to understand how the designers perceived and worked with these handmade Probes and how this feature influenced the design work. The results help to frame the insights gained about mobile interaction trajectories, and contribute to research about Probes and design communication.

4.5 Conclusion

This chapter introduced the thesis' research *through/about* design methodology. It presented the three stages of thesis research, demonstrated the *research program versions 1 to 3* and the evolution of its three programmatic research strands in the context of the explorative pre-studies (stage 1), the two probing experiments (stage 2) and the analytical design studies (stage 3) conducted.

The two main probing experiments were introduced and the Hankie Probes' core concepts were explained. Chapter 5 will explain how this middle range theory for mobile interaction design informed the design of the Hankie Probe in particular. This chapter will present the completed Probes from the two main probing experiments discussing their scope, content and presentation in design workshops. The completed Probes represent real-life examples, so called *instances of mobile interaction trajectories*. Chapter 6 will then analyse the design team's work with these and evaluate their potential for inspiring and informing generative design processes.

Chapter 7 and 8 will present the analysis of the two secondary research strands: 2a) Characteristics of the design process with the curated Hankie Probes and other influences on the design process and 2b) The value of fabric-based handmade Probes in design workshops.

Chapter 5: The Completed and Curated Probes – Design Resource Portfolio

This chapter presents the raw and completed Hankie Probes that resulted from this thesis research. The Probes are presented as a *design resource portfolio*. The portfolio describes the Hankie Probe's theoretical background and explains the inspirational sources for its particular design. The completed Probes of the two main probing experiments are presented as instances of mobile interaction trajectories, introducing real-life examples that exemplify the middle range theory introduced in Chapter 3. Further, the chapter discusses the scope and characteristics of the respondents' completed Probes.

5.1 The purpose and use of design resource portfolios

An annotated *design resource portfolio* - in the case of this thesis research - is a display of one or more user and context focused design resources, raw and completed, including a theoretical and practical description of their theoretical background, design and application. The following aims to communicate a competence (Keinonen, 2009) for user and context focused design research. It must not be understood as a design resource that has a pre-scribed method of application. Rather, the presented design resource may be integrated in a variety of approaches and may be modified and adapted to particular design settings.

A *design researcher's* resource portfolio is similar to a designer's portfolio⁴⁵. These communicate a design philosophy through the display of designed artefacts, often including text that explains the work from a design philosophical and inspirational stance. Design portfolios are a common way of communicating a work outcome in fields of design research too. In contrast to (most) designers, (user focused) design researchers are not only concerned about the outcome, but are also interested in how the outcome is grounded in insights about users and contexts, and which approaches were used to achieve the results. A design resource portfolio therefore contains more than a high-level articulation of a design philosophy, sources of inspiration or rough modes of working. It explains at a more

⁴⁵ Also compare to Gaver's (2011) *workbooks*, which convey design ideas and directions too. However, workbooks don't communicate final designs, but indicate design concepts/agendas via early illustrative outlines.

detailed level and, ideally, also presents evidence to argue for or against the resource's qualities. It needs to be detailed enough for other researchers to make use of it without being overly complex, since that could hinder adoption of new user and context focused design resources⁴⁶. The design resource portfolio's aim is to discuss the inspiration for designing the resource, its purpose, value and weaknesses.

Similar to designers, design researchers have an individual way of working. They initiate approaches and use resources that they are experienced and confident with. User focused design researchers have an individual way of working and a research philosophy to approach their work that is similar to designers. They also have particular ways to design their user and context focused design resources that they use to inspire and inform their own or others' work. User and context focused design resources are more than artefacts used as part of instrumental *methods*⁴⁷. Rather design resources represent *competences*, if not *agendas*, or both (Keinonen, 2009). Competences express design researchers' ability to approach⁴⁸ design work using particular types of design resources. It expresses their competence of leading the process and adapting the design resources to the design setting. Agendas go one step further. They represent the design researchers' stance, expressing what they think is the right way to approach user research. An annotated portfolio explains this competence (and/or agenda). It can include a theoretical description; describe preferred ways of working and present the design resource artefacts. Although a design researcher's discussion of a portfolio should apply an objective perspective, it needs to be accepted that a design resource portfolio also will reflect a design researcher's subjective stance.

This argument in favour of annotated design resources is based on a pragmatic view of design processes, which assumes that designers and also design researchers operate in unique design settings. Hence, design resources need to

⁴⁶ Rogers (2004), for instance, showed that complex user-centred approaches like *GOMS* (Goals, Operators, Methods, and Selection rules) or *distributed cognition* have never transferred to practical design contexts broadly. One reason is that these methodologies require a rather high initial preparation effort.

⁴⁷ In this thesis, a *design method* is understood as a fixed and defined procedure structuring a design process (or user and context focused design research) that promises to achieve desired ends via these predefined means. A *method* involves a number of pre-defined user and context focused design resources.

⁴⁸ In this thesis, a *design approach* is understood as a loosely framed (implicit) procedure promising for potentially achieving desired ends via vaguely defined means in a design process. An approach is associated with a number of user and context focused design resources, but does not pre-scribe their visual and conceptual design, nor their (means of) application.

be adapted for any design setting. The design and adaptation of a design resource to practical settings requires the researchers' input, experience, intuition and her/his aesthetic sense. Like with every designed object, only some of these design decisions can be made explicit and fully rationalised. Many decisions need to be taken based on experience, in the context of the design setting. A design resource portfolio provides the basis for contextual adaptation. It aims to describe the resource objectively, based on evidence wherever possible. It however also aims to support other design researchers in ways beyond objective measures. For example, it can propose new aesthetics for data presentation. The presentation as a portfolio depicts the resources as a *competence* rather than an instrument. (Keinonen, 2009).

In the case of this thesis research, the exposition of the completed Hankie Probes, including their annotation, aims to provide such information and descriptions, giving design researchers a sense of what to expect if they use this or a similar middle range theory or Probe format.

5.2 Examples of design (resource) portfolios in design research

There are various forms of portfolios in design and in interaction design research. A first type of portfolios represents theories for interaction design that are presented via prototypes and design concepts. For example, *designing for the self* by Zimmerman (2009) explores *product attachment theory* to help people become who they desire to be. *Affective Loop* interaction by Höök and colleagues is another example of a theory *for* interaction design (Sundström et al, 2005). The authors present various examples of their work, thus, a portfolio, which represents this theory for interaction design. Within HCI, such portfolios tend to be structured and explored methodologically, in order to objectify the middle range theory. Zimmerman for instance articulated design guidelines and design patterns based on his portfolio (Zimmerman, 2009). Portfolios *beyond* HCI are often broader and more romantic in nature, compared to HCI's structured and methodological approach. These portfolios are more subjective and emphasise the designer's individual stance more clearly. The aim is to express one's approach and not to research and explicate a theory for design, research or the broader design community. DesignArt studio Formafantasma introduce their work in the following way⁴⁹:

⁴⁹ http://www.formafantasma.com/about_us.html (07.12.2013)

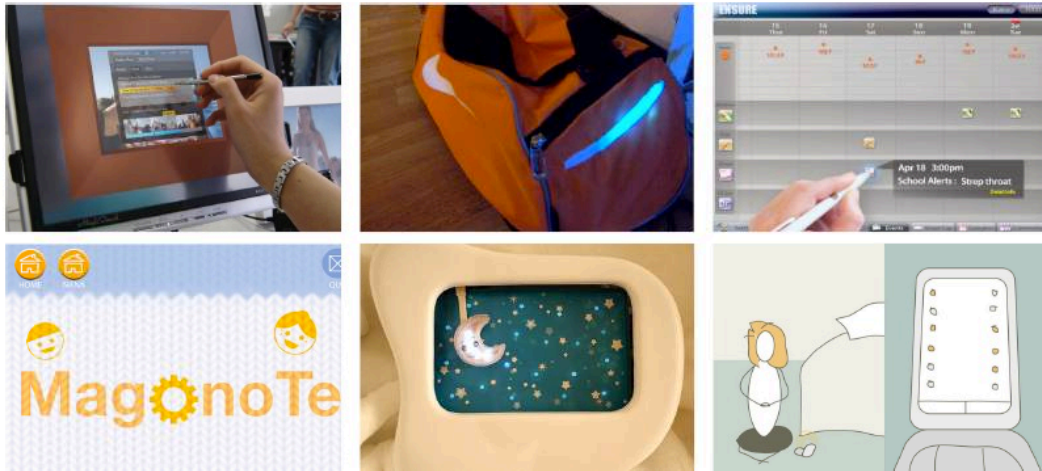


Figure 5.1: Zimmerman's range of artefacts as part of the 'designing for the self' portfolio

“Formafantasma’s work explores such issues as the role of design in folk craft, the relationship between tradition and local culture, critical approaches to sustainability and the significance of objects as cultural conduits. They identify their role as the bridge between craft, industry, object and user and seek to stimulate a more critical and conceptual design dialogue through their work.”

As discussed earlier, a *designer’s* portfolio is mostly represented by design outcomes/concepts. In contrast, a *design researcher’s* portfolio is more interested in the approaches that are used to achieve and support certain design outcomes. Such design resource portfolios describe user and context focused design research with an emphasis on the practical user and context focused design resources and the processes they are used in. An example is Ylirisku and Buur’s (2007) *designing with video*, which describes the use of video formats to capture and transfer insights to design settings. Another examples are Raijmakers et al.’s (2006) *design documentaries* or by Newell et al. (2006) *theatre practices* in user focused design approaches. Typically the resource is explained with examples and a discussion of its use in particular design settings. The portfolio highlights the resources’ positive and negative impacts. Portfolios of this nature often explore a resource’s quality, but independently from an actual design outcome that was achieved through its support.

The thesis research presented here is similar to these portfolios, but differs from them in certain aspects. First, it explicitly articulates a middle range theory for interaction design that inspires the design of the resource. It pioneers the embedding of theory within a design resource. Second, it presents the full range of used resources, including completed and curated versions. Often, only selective

and representative examples are presented. Third, it highlights the researcher's subjective stance for designing and adapting the resource. In contrast, in academic design research, it is often the aim to wholly objectify the design and application of user and context focused design resources.

The following section describes the Hankie Probe as a *design resource portfolio*, which serves as a basis for the following three analytical chapters.

5.3 Design resource portfolio: The Hankie Probe

This sections describes the resource's theoretical and practical background and the subjective inspirations that informed its design. The completed Probes as well as their content and thematic scope is discussed here. The advantages and risks of the Probes' curation are reviewed. Together these sources aim to describe the Hankie Probe's theoretical, practical and subjective characteristics as a user and context focused design resource.

5.3.1 Inspirations for the design of the Hankie Probe

I first describe the theoretical, practical and aesthetical influences on the Hankie Probe's design. The Hankie Probe is understood as a user and context focused design resource belonging to the group of (Cultural) Probes. It is considered to be a Probe for the following reasons: first, it is an artefact particularly designed for gathering and expressing insights about users and contexts for design settings; second, it aims to evocatively and creatively engage participants in open subjective self-reporting activities, to an extent and in a format and media that fits the design setting(s); third, its focus is on evoking open and subjective instances of mobile interaction trajectories offering informative and inspirational insights for design workshops.

The Probe's theoretical basis: Mobile interaction trajectories. The Hankie Probe is a probing resource that was designed for the purpose of understanding people's mobile experiences from a particular theoretical perspective. It manifests the theoretical perspective of *mobile interaction trajectories*. The Hankie Probe focuses on everyday *trajectories*, *locative* and *mediated contexts*, *intermediaries* and *moments of connectedness* that take place during daily trajectories.

The Probe captures (parts of) people's everyday trajectories crossing several places like work, home, the fitness studio or the supermarket (etc.). To capture this aspect, the Probe uses an abstract map, which is inspired by space-time diaries. Space-time diaries are often used in social-geography (Blunden 1977) to capture people's movement over time and space. This inspired the Probe's design. The circles on the Hankie Probe's left side need to be interpreted as places, which people connect by stitching or drawing. In doing, so they create an individual map showing their trajectories and places of everyday life. Choosing a visual approach for mapping everyday trajectories seemed to be an appropriate way for collecting and communicating such insights to design.

Further, the Hankie Probe captures people's *mediated communication*, hence how, when and where people use mobile communication technologies to connect with distant others. In particular, it captures their *moments of connectedness*. As defined in Chapter 3, mobile interaction trajectories, as well as the Hankie Probe, consider connectedness via portable and fixed communication devices and services. The Probe design's primarily focuses on capturing communication via portable devices and their related services, such as Smart Phones. The design also aims at capturing mediated communication via *fixed* communication devices that extend and complete people's mobile communication routines during their trajectories. The Hankie Probe requires respondents to note these communications down on their map, directly in the circles or in-between them. This aims to reveal places, practices and experiences of mediated communication during people's individual trajectories.

The Hankie Probe asks participants to take notes about contextual situations for each *moment of connectedness*. In doing so, it collects insights about *locative* and *mediated contexts*. Iacucci et al. (2000) showed the significance of those factors in inspiring design, and this is why the Probe aimed to include these aspects. Jumisko-Pyykkö and Vainio (2010) informed the Probe's design on which contextual aspects to gather. The Hankie Probe seeks to capture the social, activity and physical context as well as the product ecosystem of a situation, which describes which other communication devices are available to the user in a particular situation. The Hankie Probe provides space for these notes. The form-like design (on the right side, opposite space-time diary) invites participants to consider these contextual characteristics for each communication. The explicit use of these forms is however not prescribed.

The Probe design, in particular the use of visual space-time diaries, emphasise the middle range theory's *focus on trajectories*. Creating a visual map draws attention on the Probe respondent's physical mobility and locative contexts, highlighting these over mediated contexts. In contrast, the Probe design incorporates mediated communication less prominently. Rather, moments/periods of connectedness, changing states of connectedness as well as mobile communication routines and their motivation are addressed in the debriefing interviews with Probe participants. This increased attention on physical mobility was balanced when curating the completed Probes. Annotating the space-time diaries was a way of integrating insights about mediated contexts and mobile communication routines in the Probes' presentation.

The design of the space-time diary and the forms for contextual note taking are designed for a one-week study. The number of places that the space-time diary shows, and also the number of forms for contextual note taking, were derived by self-trials that preceded each of the two main probing experiments. This showed that the Hankie Probe's basic features seemed to be appropriate for the topics and scope of both main experiments. Its graphical style is a result of some iterations and trials on paper and fabric, based on feedback from supervisors and colleagues. The visual appearance aimed to achieve a practical frame, without appearing as a questionnaire. The graphic design, as well as the entire Probe, should appeal to respondents and design teams in equal measure.

This basic design can be extended for particular research topics and application domains. For example, for the first of the two main probing experiments, I included *imaginative mobility*, which referred to people being reminded of each other by digital means, e.g. facebook comments on other people's threads and non-digital signs like a picture of a person on an office desk (etc.). Respondents were asked to track such occurrences with tags that were attached to the Probe package. Respondents could also write on the completed tags and then attach them to the fabric. This aspect of the Probe was however only applied during the first probing experiment on mobile relationships, and made less sense for the second probing experiment on mobile work communication. I also dropped this aspect because it had no major impact during the design workshops of the first probing experiment.

The Hankie Probe's fabric format. The Hankie Probe is based on a *fabric-based format* allowing Probe respondents to complete the Probe using materials and practices such as fabric, embroidery, stitching and drawing. The Probe's fabric format is seen as an enabler for these practices. A Hankie Probe that has been completed using these practices is understood as a *handmade Probe*. The choice of fabric was inspired by explorative pre-studies during stage one of this thesis research (see *Chapter 4 Methodology*).

The fabric supported the work with visual maps and introduced a new element for expressing the space-time diaries. Stitching daily trajectories onto the fabric aimed to create individual space-time diaries. However, the use of fabric also promised to provide an unusual way to interact with Probe respondents and design teams. These purposes are now discussed.

On the one hand, the use of fabric promised to introduce a robust design that Probe respondents could carry around in bags and pockets. The addition of tags, threads and needles however foiled this intention. Unsurprisingly, respondents did not use it as ubiquitously as imagined, because of these additional items. On the other hand, the fabric promised to create a Probe Package that was different in terms of look, feel and mode of interaction. Fabric, needles and threads aimed at a playful and gimmicky appearance. This was inspired by my personal desire to work with artefacts that were less standardised than default Probe packages and that enabled a playful and funny way of engagement. This design, I assumed, would make the engagement with Probe respondents easier, because the Probe asks them to do something unusual. Sewing trajectories onto a piece of cloth can be a comical act too, because it is quite different from the medium that the probing experiment is looking at: mediated communication via digital information and communication technologies.

As well as aiming to be robust and different (playful, fun, unusual, even comical), the artefact is designed to make Probe respondents express their personal behaviour and experiences in a way that provides a basis for discussion and dialogue in a debriefing interview. The resulting handmade artefact itself was not expected to be fully self-expressive, but should prompt experience accounts in interviews. It was expected that some Probe respondents would decline to use needles and threads. This was a limitation of the Probe, but respondents were given the freedom to draw instead of using the embroidery tools. The Hankie Probes did not require a certain way to be used in order to benefit design work. In

contrast, the use of fabric, needles and threads was expected to lead to interesting insights through misuse.

The choice of fabric was also influenced and informed by the future design settings that the completed Probe was going to be used in. The use of fabric-based formats promised the possibility of transferring the completed Probes to design workshops as *originals*. This requisite was informed by Mattelmäki's work on *design probing*. She reported that designers benefit from the original data sources, such as drawings (Mattelmäki, 2007). I also expected an unusual research material and practices, such as fabric needles and threads to catch Probe respondents' and designers' attention, making them eager to explore the curated Probes.

5.3.2 Comparison with other Probe agendas and formats

The Hankie Probe is one form of (HCI) Probe, but its agenda is different from the one of the original Probe package presented by Gaver et al. (1999). This section will examine how the Hankie Probe can be considered to be a Probe, despite its differences to the original and to other Probe formats. Over the last decade a variety of Probe formats have been proposed and discussed. For example, within the HCI community Probes were used as *Informational Probes* (Crabtree et al., 2003). In a broader design (research) context, Probes have been called *Design Probes*. Mattelmäki (2007) has discussed a number of formats and application strategies that differ from the original Probes. Similarly, design research has presented a number of approaches that show similarities with probing, like *Context Mapping* (Visser et al. 2005). The Hankie Probe is more similar to these alternative Probe adaptations than to Gaver et al's (1999) original Probes format, agenda and application.

This thesis research uses a pragmatic understanding of design processes, meaning that *probing* is understood as designers' and design researchers' competence to design, adapt and apply design resources in unique design settings. Hence, it is accepted that agendas change, and resources are adapted, according to the requirements of these unique settings, and consequently that the Hankie Probe's application differs from other forms of Probe use. Clearly, the *Hankie Probe* has a different agenda than the original *Cultural Probe*, and is used in a different practice-led design setting. However, the Hankie Probe's application shows similarities with work that is considered to be *probing* in a broader design context. It is therefore plausible to consider the Hankie Probe (and its particular

application in this thesis research) to be part of the family of (HCI) Probes - due to its focus on subjective and open data collection approach.

The Hankie Probes' agenda (in this thesis research) shares some qualities of *Informational Probes* (Crabtree et al., 2003) that aim to collect and communicate a (structured) set of information, which is still *biased and partial* (Crabtree et al. 2003), but different from a vague, random and rather unstructured collection of inspirational insights that Gaver et al's (1999) *Cultural Probes* gather. In this thesis research, the Hankie Probe was applied within the constraints of research through design that included qualitative analysis, which required to control its application to a certain extent. Therefore, the Hankie Probes' application for this thesis research's purposes restricted its potential to a less open, but more guided and structured application, similar to the use and purpose of *Informational Probes*. The following will discuss differences and similarities with other Probe agendas with more detail.

First, the original Probes were designed for target groups that weren't accessible to the research team (in terms of location) – hence there was no direct interaction between researcher and Probe respondents. In this thesis, the Hankie Probes are used in direct (face-to-face) interaction with respondents. The researcher introduces respondents to the Probe and debriefs them afterwards. This Probe application differs from the original Probes by Gaver et al., but is similar to Wallace's (2007) use of craft-based Probes and to approaches like *Context mapping* (Visser, 2007), which includes direct interaction with Probe respondents too.

Second, Gaver et al's (1999) target group was somewhat alien to the design team. Not only did they live in another country, they also had another demographic background. It was Cultural Probes' aim to gather insights about the target group within these constraints. In contrast, this thesis research used Probes in a design setting that has access to the target groups. Different Probe adaptations over the years have shown that probing is a fruitful approach in settings where researchers have access to Probe respondents, but also in settings where Probe respondents are not necessarily alien to design teams in terms of demographic background. A good example is Visser's (2011) work on the design of shavers, for which she used a probe-like approach to work with target groups and designers who showed similar demographic backgrounds.

Third, It is a common strategy for designers to design the Probe packages themselves. In this study, the Probe was designed by the thesis researcher, who did not produce design outcomes himself. While this may seem atypical in comparison with the original *probing* agenda, it is a rather common approach in a broader design context. For example, Vissers (2011) and Mattelmäki's (2007) work show Probe applications with similar characteristics, also discussing different forms of Probe curation before presenting the Probe to design teams (who did not design the Probes themselves). The Hankie Probe's agenda was similar to these examples, and influenced by the thesis research's aim. It was chosen as a *research-through-design* approach that allows analysing designers' work with completed Probes from a more objective position: The design researcher does not analyse his *own* design responses to the completed Probes, but *others'* design work with the Hankie Probes. This separation between Probe design and Probe use aims to introduce a more objective stance for evaluating the Probes' qualities and mobile interaction trajectories' value in design workshops.

This setting diminished some of Probes' qualities. For example, it diminished the Probe's potential to thwart designers' pre-existing understanding about users and contexts throughout the *probing* process – because in this research they are only presented with the completed and curated Probes, but are not involved in designing them. Designers do not experience how *their* Probes are completed unexpectedly or even misused – the process that can change perspectives and pre-existing opinions. On the other hand, designers are presented with curated Hankie Probes that feature a novel theoretical perspective on mobile interaction. Consequently, designers are likely to deal with a novel and unexpected perspective on users and context anyways. Therefore, in this research setting the completed Hankie Probes may still thwart designers' pre-existing understandings. However, this aspect does not affect the thesis research, because it is not the aim to evaluate the Hankie Probe's potential to introduce such surprising elements – although this would be a valuable research aim too. Rather, the Hankie Probe is a means to collect real-life examples of mobile interaction trajectories' in order to evaluate their aspects' *quality* in design workshops. The Probe's application and analysis is aligned to this aim.

The Probe's handmade format: The Hankie Probe shares characteristics with existing Probe designs, e.g. presented by Mattelmäki (2006). In particular, it has common characteristics with Wallace's (2007) Probes' use and format. It is this the

use of materials that are associated with skilful craft. However, the Hankie Probe should not be considered to be a 'crafted Probe'. In this thesis, the term *handmade* is used for referring to practices for manipulating the Probes' fabric format, such as stitching, embroidery and doodling on the fabric. The term *handmade* aims to describe completed Probes that show individual styles and marks of completion that result from the Probes' fabric format and related practices. The term *handmade* is chosen over the term *craft*, since the Probe respondents do not require a special skill set or training for Probe completion using these practices. Similarly, the thesis researcher is not a trained crafter. The making of the Probe's fabric elements, e.g. silk printing, required input and advice by expert personnel – e.g. technicians and trained crafters. Therefore, the making of the Hankie Probe may also not be considered as *craft*.

5.3.3 The raw, completed and curated Probes

This section presents the *completed Hankie Probes*. It introduces the Probe design and explains its individual elements, the space-time diary, the forms for contextual notes, etc. Each respondent's completed space-time diary is displayed and annotated to highlight its particularities. Further, the section presents the themes that the Probe interviews revealed, and motivates the curation process.

Instances of mobile interaction trajectories: The design resource portfolio presents the *curated Hankie Probes* as they were presented in the design workshops. Each curated Probe represents an *instance of mobile interaction trajectories*, which are considered as real-life examples explicating this middle range theory. As explained in *Chapter 4 Methodology*, each completed Probe was curated and presented with a summary, selected quotes from the interview, a short persona description, and both original and annotated versions of the space-time diary.

Presentation of completed Probes and annotated space-time diaries of
Probing experiment one:

Mobile Relationships (MRS)

Completed Probes and their particularities, including short summaries of respondent interviews and the Probes' curation for their presentation in design workshops.

Due to the format of this document, the curated Probes (presenting instances of mobile interaction trajectories) can only be presented in condensed form, introducing each instance's gist. The full version of each curated Probe is documented in Appendix 5.1.

Note: the following completed Hankie Probes focus on the presentation of the space-time diaries. Contextual notes on the completed Probes are not highlighted, but represented by summaries and quotes taken from the debriefing interviews. Full legible versions of each completed Probe including contextual notes can be found in the Appendix 5.4.

The Hankie Probe for Probing experiment one

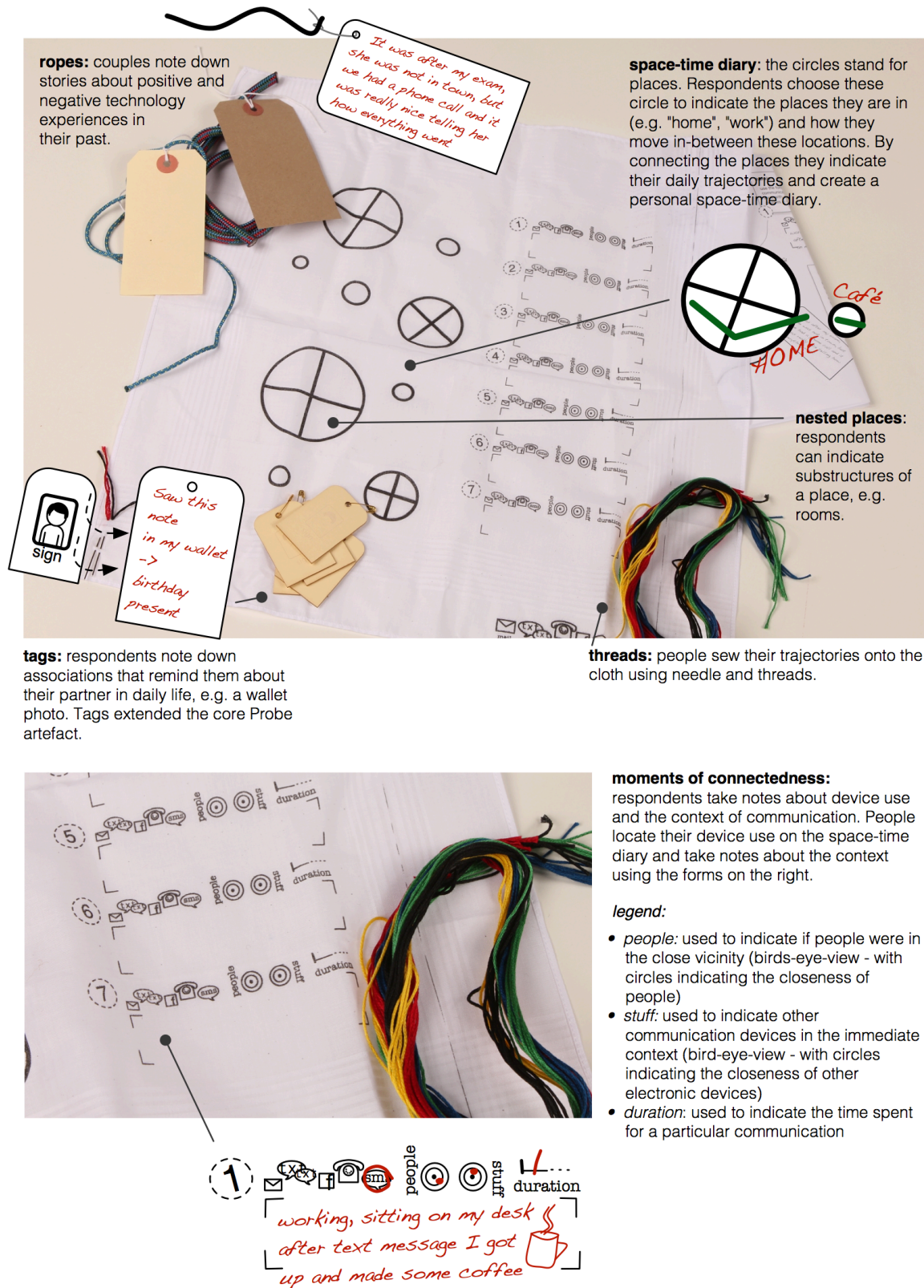


Figure 5.2: Raw Hankie Probe for probing experiment one. A legend printed on the hankie explained the communication icons (txt, 'sms', etc.). Furthermore, respondents received a summary of instructions with the Probe package.

Making, Testing and Analysis

Before working with five couples, I conducted a self-trial with my girlfriend to test the Probe concept. We recorded for one week. The insights from this trial were used to re-design the Probe. The use of the space-time diary seemed appropriate. However, the forms to take contextual notes were iterated. There was too little space to take notes and to write on the fabric. I then dedicated more space to take notes for each communication, and with the same rationale, I introduced 'tags' which could be labelled and tacked to the fabric. Based on feedback from supervisors and colleagues, the Probe's visual style was advanced.

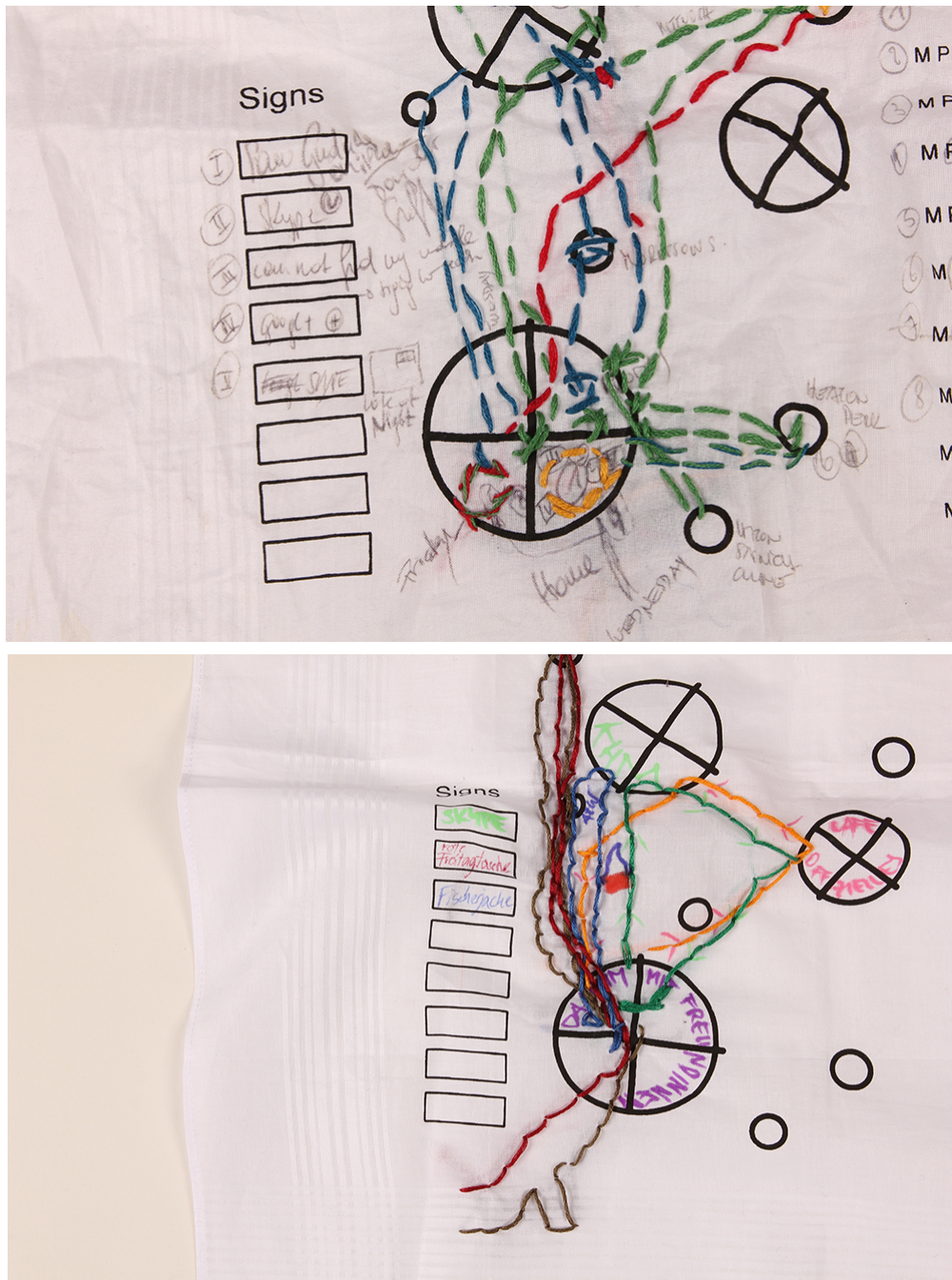


Figure 5.3: Results of self-trials with an early version of the Hankie Probe for probing experiment one (my completed Hankie Probe on the top, my girlfriends Hankie Probe at the bottom).

Introducing the Probes to Probe Participants:

The packages were introduced to Probe respondents personally in form of Probe packages as they are shown below.

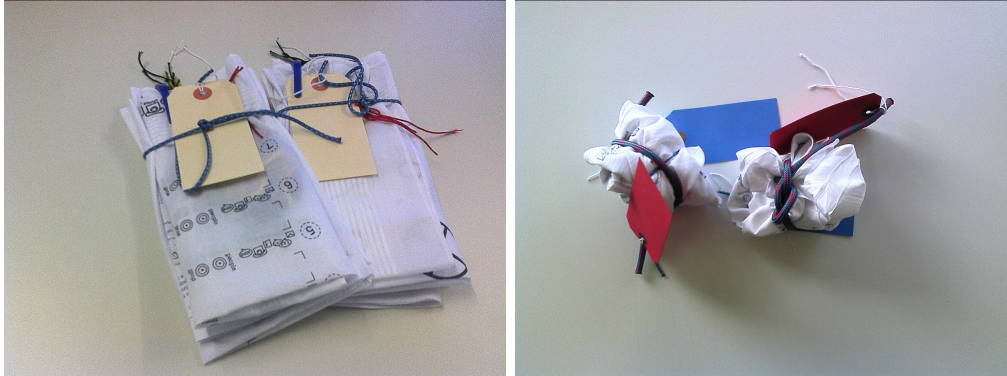


Figure 5.4: Example Probe Packages as handed over to Probe respondents. Two couples received the Hankie Probe carefully folded. Three couples received the Hankie Probe as a little 'rumped ball'. In both cases, needles, threads and additional tags were wrapped in the fabric. I started to wrap the Probes differently for the introduction session to show that respondents were not expected to treat the Probes with particular care,

On average, each introduction session lasted for 30 minutes. The Hankie Probe's core concept was explained to the respondents. I introduced the space-time diary and explained how to understand the forms to take notes about the context of their moments/periods of connectedness.

Respondents were told that it was up to them how to indicate their trajectories and how to locate each communication on the space-time diary. They could choose how to express and draw their space-time diary. They were told that their recordings were only the basis for a follow-up interview on return of the completed Probe.

I suggested recording as soon as possible after each communication and to carry the Probe with them.

Respondents MRS1

<p>General:</p> <p>Couple 1 is in their late 20ies/early 30ies. They are both teachers and live in a shared flat. Time of recording: late autumn 2011. Recording duration: One week (5 working days and 1 weekend). They were interviewed individually, one after the other. Interviews took place on separate days. This arrangement was due to their schedules. For the design workshops, I named them Susi and Strolch (the German name for Lady and Tramp).</p>
<p>The interview revealed 6 thematic clusters</p> <ul style="list-style-type: none"> • They contact each other after work • They contact each other before going to bed (in case they stay at different places) • They have particular ways of staying in touch, if separated over a longer period of time • The study revealed a one-off example. They use sticky notes to ask questions to each other. • They reported a situation in which one was convincing the other to come to town (cinema) • They talked about contextual experiences, e.g. walking to school and not wanting to use the phone (periods of disconnectedness)
<p>Curation criteria: Selected instance of mobile interaction trajectories</p> <p>This couple's most prominent theme was their after work communication routine. They use to contact each other during their commute home (calls and text messages). This appeared as a routine and I decided to call their ensemble 'mobile routines'. A mobile communication routine like this was a good example of a mobile interaction trajectory: It shows a reoccurring communication routine that is embedded in the respondents' everyday trajectories, clearly structured by the respondents' everyday activities.</p>
<p>Probe use:</p> <p>She kept it at home and took it to school. When taking it with her, she kept it in her pocket or bag. She recorded in the evenings. He took it with him. In the beginning, he recorded immediately, but then changed to recording once a day, mainly in the evenings. They recorded every communication with each other, including short descriptions (keywords) of the content and context of each moment of connectedness.</p>
<p>Fabric and Stitching:</p> <p>SHE: "<i>Stitching was too cumbersome after some time. Writing on the fabric was cumbersome too. Although, it is a beautiful fabric.</i>"</p> <p>HE: "<i>The writing on the fabric was a bit cumbersome. In the beginning the stitching was fun. You have to make up your mind a bit. That is better than having to come up with something immediately. The stitching took too much time after a while and I got tired of it.</i>"</p>

Table 5.1: Summary of Probe Respondents MRS1's interview and Probe use

Respondents MRS1's space-time diary

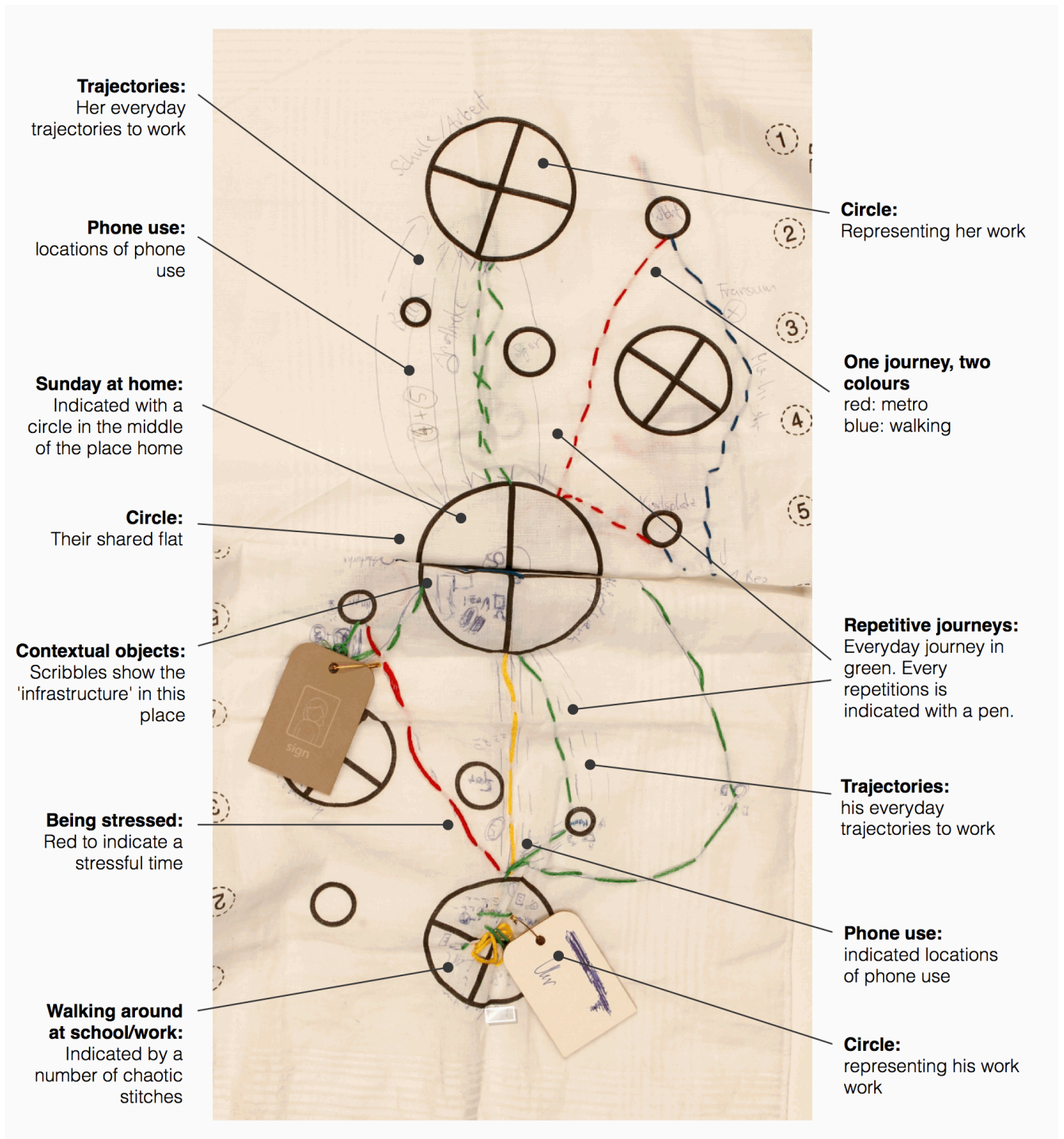


Figure 5.5. Couple MRS1's completed space-time diaries, annotated by the thesis researcher. Two space-time diaries above one another, creating the couple's map of daily trajectories and places

ensemble 1: mobile routines

The Example of Susi and Strolch: *getting in touch after work*

The two of them have **one particular routine** for staying in touch. Actually, it is more about "getting in touch". This routine comes into play after work or when they are on their commute trip. It is almost a way of kicking-off their relationship.

who they are

...they are a couple in their late 20s/early 30s. They live together. They are both teachers. During a normal week they spend their mornings and most of their afternoons at school (each of them at a different one). They have different morning routines, which means they don't necessarily get up at the same time.

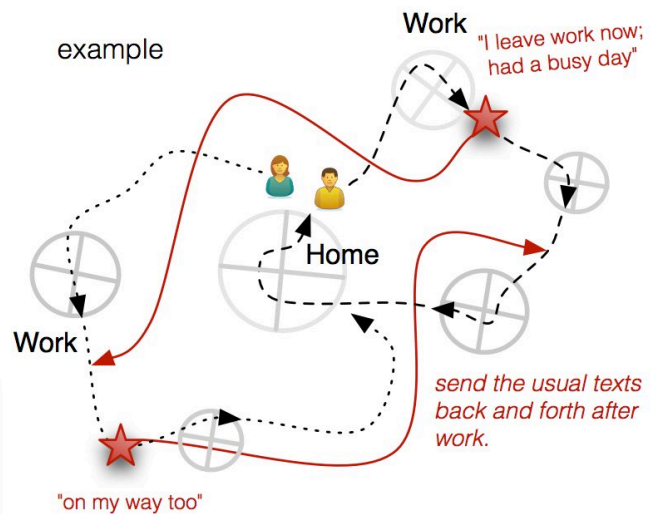
They like writing sticky notes and leave them on the kitchen table. These are notes about shopping, food or sometimes a question, which they then follow up via text messages, calls or later when they meet again. They both consider their **flat as their "base"**.

quotes from the interview

SHE: "At home is like a meeting point for us, I call to find out if he is there. It is a way of arranging things. Will we be doing things together? food?... something else?... or are we busy the both of us?" It **opens up a space of options for being together.**"

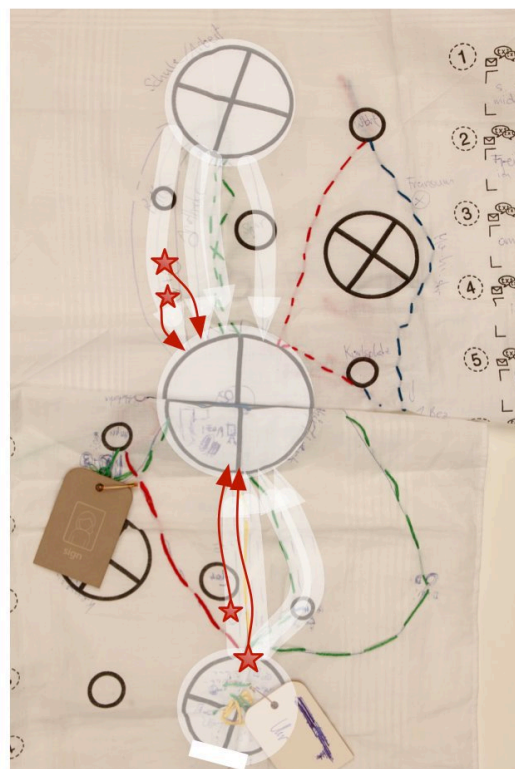
"If I want to know something, I call, but often I just write a text to tell him what I will be doing ... and then it is up to HIM to decide whether he wants to be part of my plan yes, these things happen mostly on my way home"

HE: I was wondering where she was, because normally she comes home earlier than me. I did not want to pressure her or so ... These things are ritualised. Normally the person who is on the way back home calls or texts. This time it was the other way round. Sometimes these things are about **"busyness" like groceries, etc. but this one is just about "getting in touch",** even if we see each other right afterwards.



annotated space time diaries

parts of the space-time diary that are relevant for the scenario
(annotated by the researcher)






-  Location and direction of a text message
-  A relevant place for the instance
-  A relevant trajectory for the instance

Figure 5.6. Curated Probe of couple MRS1 introducing the instance of mobile interaction trajectories.

Respondents MRS2

<p>General:</p> <p>The respondents are a couple in their late 20s. At the time of Probe completion they had starting dating only recently. They lived in separate apartments in the same town.</p> <p>Time of recording: early 2012.</p> <p>Recording duration: They recorded for one week.</p> <p>By request I interviewed them individually.</p> <p>For the design workshops, I called the couple Bernard and Bianca.</p>
<p>The interview revealed 5 thematic clusters.</p> <ul style="list-style-type: none"> • The study showed their mobile routine: Arranging times and places to meet, eventually leading to longer phone calls. • He tries to break their mobile routine with little poems via SMS • The interview revealed contextual appropriations of phone calls (the things they do while phoning other people, e.g. walking around in the flat) • One-off situations: The interview revealed communications for micro-organisation, e.g. phone calls to tell her he was waiting outside the door. • The couple talked about their media selection for particular types of communication.
<p>Curation criteria: Selected instance of mobile interaction trajectories</p> <p>The couple do freelance work. They reported not having a strong work-life routine, e.g. going to work and back on a daily basis. Instead they had a prominent mobile communication routine. They use phone calls to agree on meeting times and places. On these occasions, they eventually engage in rather long phone calls discussing various things. However, the male respondent sometimes sends little poems to his girlfriend. She perceived these exceptional texts as nice, almost as 'presents'. It breaks their mediated communication routine and is different from the normal and everyday communication. I decided to focus this Probe's presentation on this aspect. The small <i>digital presents</i> seemed to be a worthwhile example of mobile interaction trajectories. This completed Probe did not show clear (everyday) trajectories. Therefore, the presentation focused on one reoccurring mobile communication routine: the digital gifts in form of poetic text messages that interlink the couple's trajectories, contrasting their regular mediated communication to agree on times and places to meet.</p>
<p>Probe use:</p> <p>He liked the task of recording, because this sharpened his attention on his communication routines. He carried the hankie with him and recorded in two larger steps. He took notes in his notebook and transferred them to the space-time diary later. She kept the Probe at home, took notes in a notebook and transferred them to the space-time diary later. They recorded each moment of connectedness, expressing it with a few keywords and notes about their content and context.</p>
<p>Fabric and Stitching:</p> <p>HE: "I liked dealing with the object itself, it was cool and it caught other people's attention." SHE: "The stitching was nice, it is nice to do such things. I did more than necessary, but it is nice to do such things."</p>

Table 5.2: Summary of Probe Respondents MRS2's interview and Probe use

Respondents MRS2's space-time diary

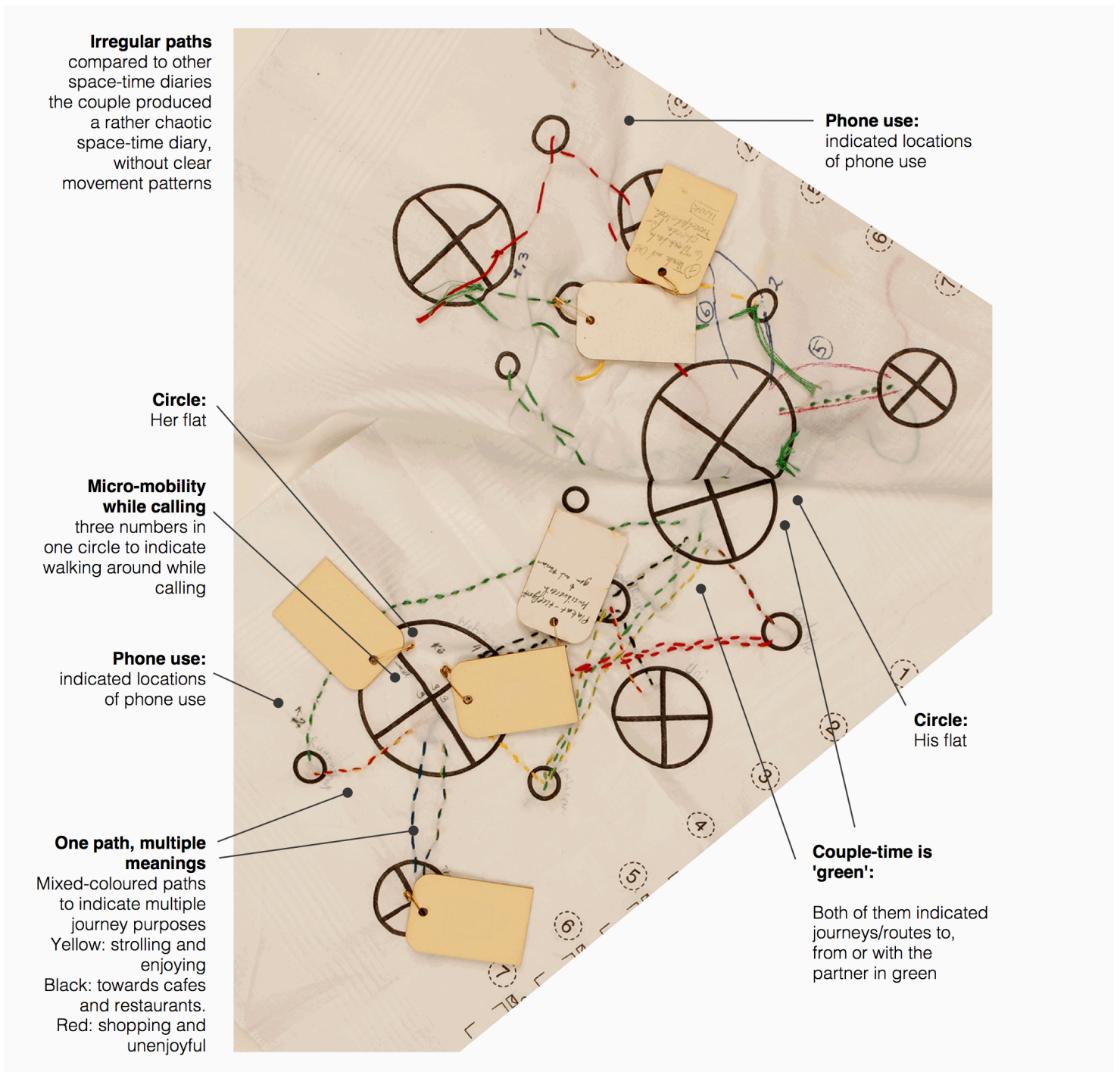


Figure 5.7. Couple MRS2's completed space-time diaries, annotated by the thesis researcher. Two space-time diaries above one another, creating the couple's map of daily trajectories and places.

ensemble 2: breaking with mobile routines

The Example of Bernard and Bianca:

Bernard is breaking the rule!

Bernard and Bianca don't live together. They use to phone each other, also to share intimate things. This is their routine. **Bianca enjoys Bernard's jolly and cryptic messages (that break that routine).** He sends DIY poetry to her. She really enjoyed that, because she likes his use of language, and does not need to react to these messages. They are just there to be enjoyed

who they are

... are a couple in their late 20s/early 30s. They have met only recently and are freshly into something like a relationship. Everything is new. Everything is exciting. They are both students and like to be in the city, they regularly visit restaurants and café's, either together or with other friends.

They both like to give presents to each other, all of which are concerned with their interests in culture, music, literature and theatre

quotes form the interview

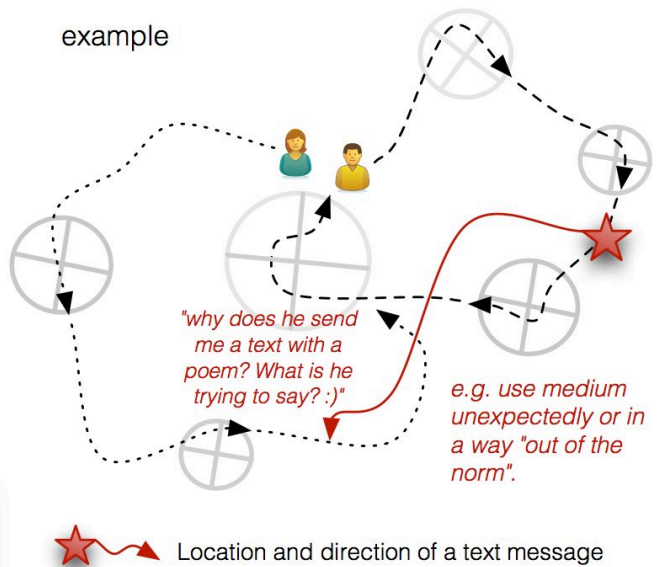
SHE: "I received a poem and an MMS. I am not really good with these things. I cannot read these things with my mobile phone. But **I was looking forward to looking it up on my computer.** I had to check on my provider's site. This one was very nice [the poem]. I had been curious what to expect. In the end it took me three times reading it to understand, which I quite liked.

I did not have to respond, **these things [the poem and the MMS] were just there to be received and to be enjoyed.** Plus, there were no questions in it, no things to be answered, which is quite nice.

HE: Maybe that's the reason why I write cryptic text messages. I hope that other people call back.

"Phoning is an intimate thing for me."

example



annotated space time diaries

parts of the space-time diary that are relevant for the scenario (annotated by the researcher)



Notes on tags that describe poetic text messages positively

Figure 5.8. Curated Probe of couple MRS2 introducing the instance of mobile interaction trajectories.

Respondents MRS3

<p>General:</p> <p>The couple is in their late 20. They both work on their PhD at the same university, although in different departments. They live in the same town in two separate flats.</p> <p>Time of recording: Autumn 2012.</p> <p>Recording duration: They recorded for one week.</p> <p>They were interviewed together.</p> <p>For the design workshops, I called them Daisy and Donald.</p>
<p>The interview revealed 5 thematic clusters</p> <ul style="list-style-type: none"> • Imbalanced communication: He is pursuing contact during the day. He is proactive. She only reacts to his text messages and calls. • Mood transition: Her mood for instigating communication changes. She is more active in the evening than during the day. • They use text messages for arranging coffee and lunch breaks. • The interview revealed that their media choices for staying in touch with each other depends on time and place, e.g. work vs. home. • They talked about how they contextually adapt their text messages during work activities.
<p>Curation criteria: Selected instance of mobile interaction trajectories</p> <p>I decided to focus this couple's curated Probe on their imbalanced communication during weekdays. This was a dominant theme on the space-time diary and in the debriefing interview. While he felt the need to stay in touch, she experienced the need to respond to his messages as a burden next to work. Only in the evening did she get in the mood for communication. This imbalanced situation, their different state of connectedness during the day, their communication chronology as well as her mood shift seemed to be a good example of a mobile interaction trajectory. This focus offered an instance showing how communication is influenced and structured according to people's individual trajectories. It also introduced an example of how being connected over time is subject to moods and contextual aspects of another person's trajectory.</p>
<p>Probe use:</p> <p>They both took the hankie with them, but did not use it ubiquitously. He recorded directly. She took notes in a notebook and transferred it later. HE: "I found it interesting but difficult to have the package around you all the time. It is easy in the office, but difficult when walking around." SHE: "It was difficult to use it 'on the go', it was playful, but I would prefer a little notebook, as I am a bit stressed these days." They recorded content and context of communications with keywords.</p>
<p>Fabric and Stitching:</p> <p>HE: "<i>It is interesting, but I did it afterwards</i> [note: at the end of the recording time]." He used several threads and colours to indicate paths. He stitched the space-time diary at the end of the week. SHE: "I did not have time to do it." She only used one thread, which was already placed in the needle when the Probe package was handed to her.</p>

Table 5.3: Summary of Probe Respondents MRS3's interview and Probe use

Respondents MRS3's space-time diary

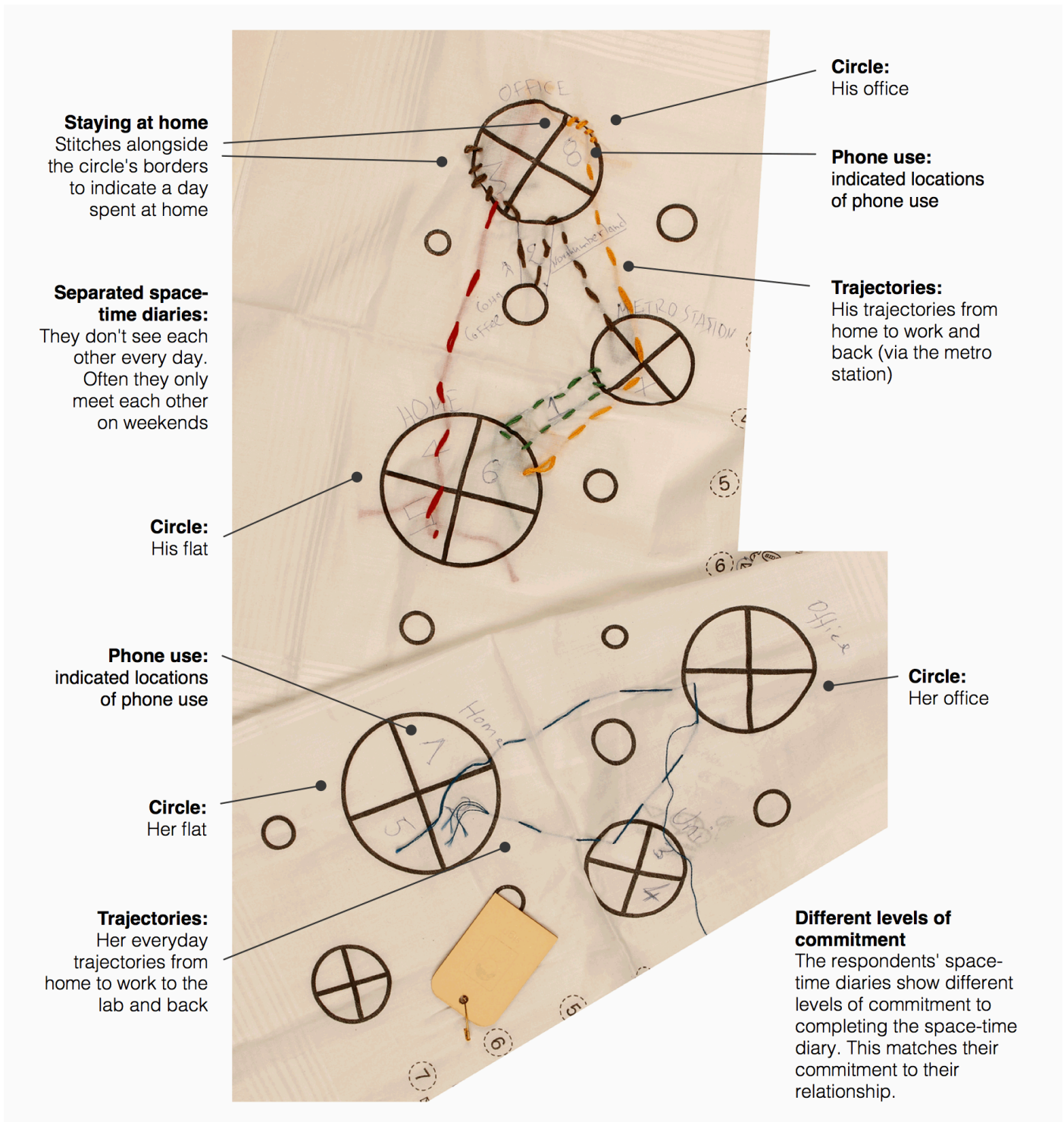


Figure 5.9. Couple MRS3's completed space-time diaries, annotated by the thesis researcher. Two space-time diaries above one another, creating the couple's map of daily trajectories and places.

ensemble 3: mood transitions

The Example of Daisy and Donald:

Daisy is too busy during the day

During the week Daisy and Donald live their relationship via calls and texts. On weekdays, Donald is the active part. **Daisy only reacts to his messages**. She has got no time and is too busy with work. She does not take breaks. She gets into the mood for communication only in the evenings.

who they are

... are a couple in their late 20ies. They are both academics working at university (although at different offices). They live in separate flats and have different routines. Their face-to-face relationship mostly happens on weekends, which they usually spend together. During the week they keep in touch with calls and text, and sometimes via Skype

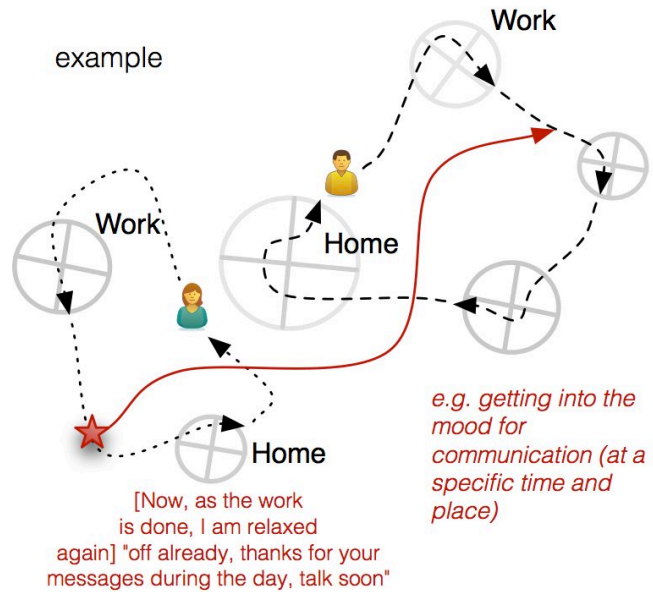
They describe their communication as contentless communication: "Where are you, I miss you and BLABLABLA". He is the active part of their communication. During work he instigates quick conversations, trying the pursue her for a coffee or a quick chat.

quotes form the interview

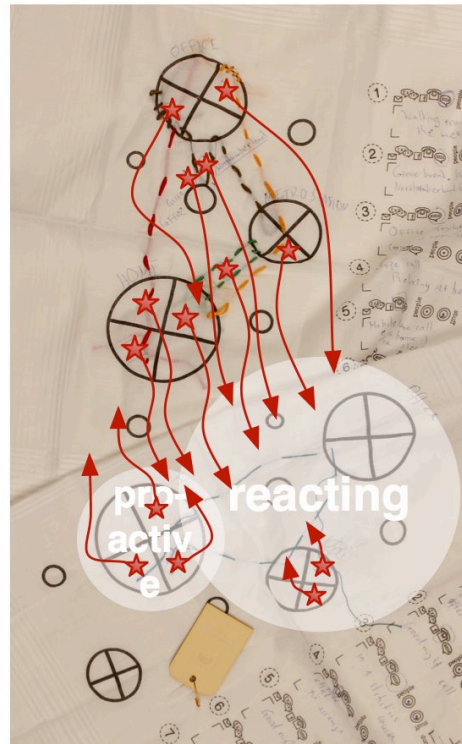
SHE: "when messages are coming in from him, for instance, they interrupt me from work; at least in these conversations I had to work, listening or text at the same time. But when I instigate a conversation then it would be a moment when I take a break... I don't even take a break (laughs); I would be perhaps moving from point A to point B, or mhhh, yeah.

But to be honest, most of these messages here are in the office in-between work, because he contacted me. And my messages come rather in the evening when I go to sleep, then I initiate.

HE: I don't have a fixed routine. Sometimes I stay longer, come later, or vice versa. But I definitely know she gets up earlier, stays at the office till 5, 6, 7. **So, I know the end of her working day. I know that it is more likely to have a communication then.**



annotated space time diaries
parts of the space-time diary that are relevant for the scenario
(annotated by the researcher)



Location and direction of a text message
different places; different moods

Figure 5.10. Curated Probe of couple MRS3 introducing the instance of mobile interaction trajectories.

Respondents MRS4

<p>General:</p> <p>The respondents are in their late 20, early 30ies. They share a flat. She works at an office 9 to 5. He is a freelancer, with an office at his parents' house, which is located close to their shared flat. Time of recording: Autumn 2012. Recording duration: They recorded for one week. They were interviewed together For design workshops, I called them Popeye and Olivia.</p>
<p>The interview revealed 6 thematic clusters</p> <ul style="list-style-type: none"> • She wants to learn about the progress of the van repair • During the day they use to call and text each other for organising dinner. • They communicate with each other organising climbing trips with friends • One off situation: They used text messages and email to sort out travel arrangements for a visiting family member. • They use to call each other asking about personal well-being (“How are you?” “Are you alright?”) • The interview prompted accounts about how he manages several communication media simultaneously at his office. They talked about media choices in these particular situations.
<p>Curation criteria: Selected instance of mobile interaction trajectories</p> <p>I focused their Probe on her desire to be updated about the van repair. This followed a routine starting from mid morning. Every day she sent several text messages to him asking about his progress. The combination of places (office vs. van repair workshop) and the chronology of their communication was a particularly expressive instance of mobile interaction trajectories. This focus created an example for which two distant places appeared as permanently linked to each other via communication media. The respondents' way of staying in touch was deeply related to particular places and times, introducing a set chronology and routine of communication.</p>
<p>Probe use:</p> <p>SHE: She kept the space-time diary with her for a few days, but then left it at home. She recorded the space-time diary at the end of the recording week. During the week she took notes in her notebook transferring them to the space-time diary later. HE: He did the recording in two steps. He was too busy and could not do it on the spot right after each communication with his partner. They did not record every single communication, but summarised a few text messages under one entry. Both took notes about their moments of connectedness, expressing the content and context with a few keywords.</p>
<p>Fabric and Stitching:</p> <p>SHE: She stitched and mentioned that she wanted it to look pretty. HE: He did not stitch, but used a pen to draw his space-time diary.</p>

Table 5.4: Summary of Probe Respondents MRS4's interview and Probe use

Respondents MRS4's space-time diary

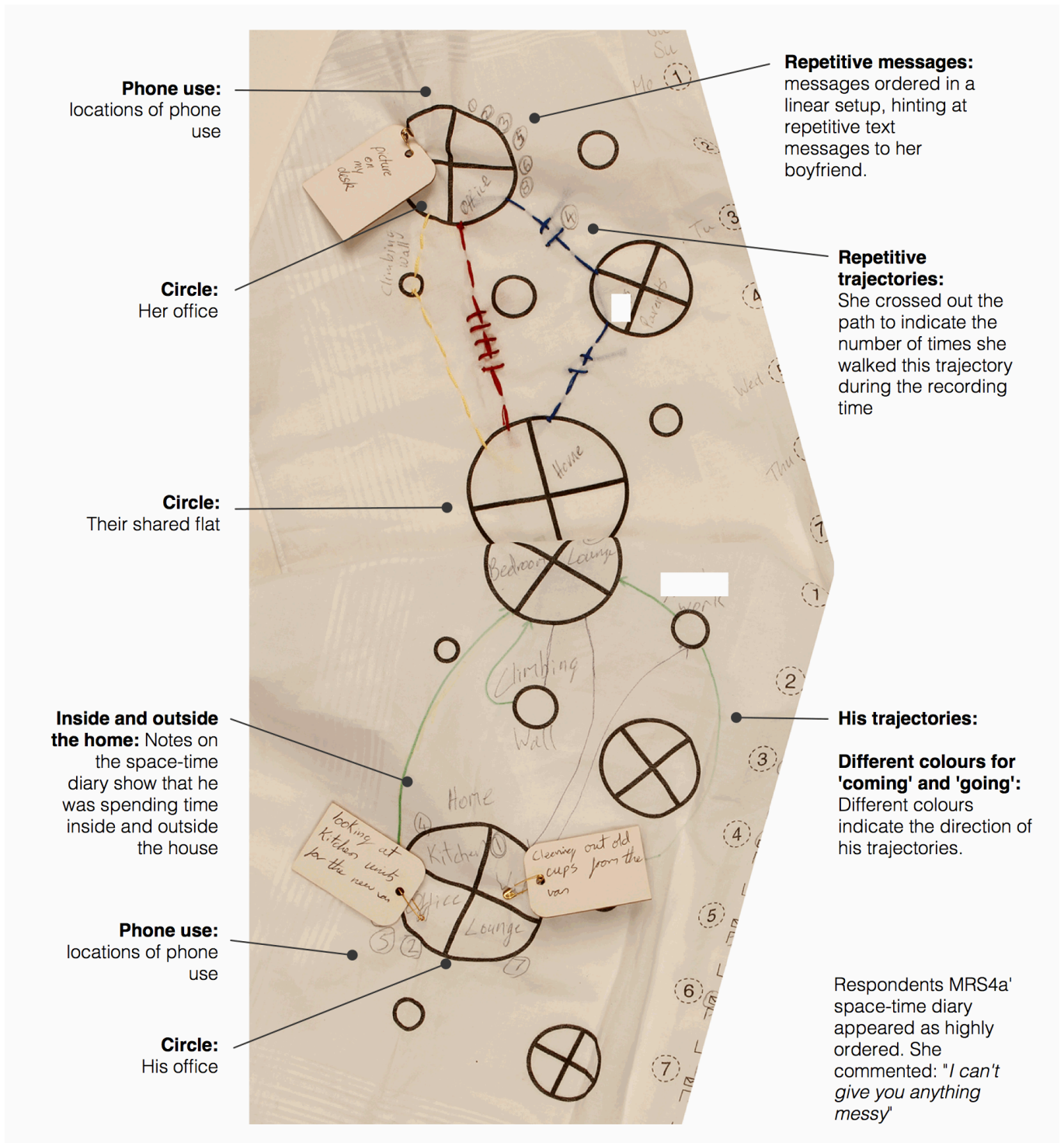


Figure 5.11. Couple MRS4's completed space-time diaries, annotated by the thesis researcher. Two space-time diaries above one another, creating the couple's map of daily trajectories and places.

ensemble 4: I want to be a part in that

The Example of Popeye and Oliva: He fixes the van for the great move

Popeye and Oliva are about to move to another country. Popeye is working in his home office, but at the same time he is fixing their camper-van that they need for their move. Working at her office, she sends text messages to get a feel of how the project is moving on.

who they are

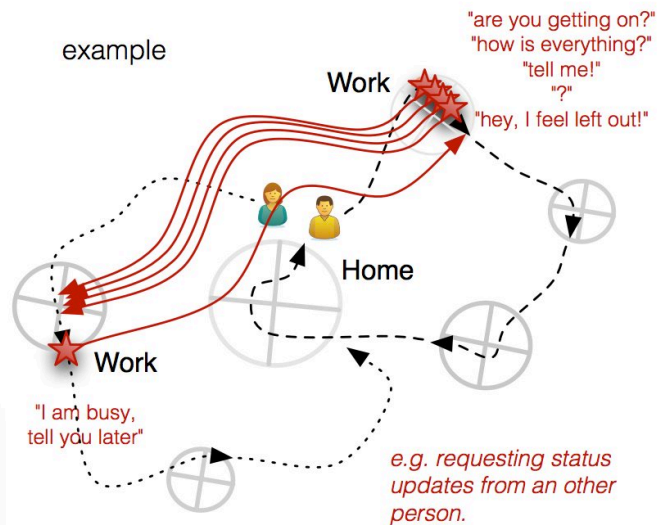
They are couple in their late 20s/early 30s. They live together. Normally, they part in the morning. She starts work early morning and is already at work when he gets up. He is self-employed and has got an office at his parents' place,

They describe this ongoing **chit-chat via texts as a substantial part of their relationship**, although they say it's mainly about food, about "how things are?" and, for instance, about ongoing projects like the van. They feel there is a certain rhythm to this communication and if it breaks something seems wrong

quotes from the interview

SHE: "Most of the messages are here in my office. I send you the most "crap" [directed at him]. Its nothing really deep, its really trivial stuff. I went through my phone, to summarise a bit, but I thought they are all the same. Nothing substantial, really. I asked about how the van was, how his day was and what kind of food we gonna have. thats pretty much it every day. **Basically, I asked for little updates.** How is the van going? what are you doing? - We use "whatz up" most of the time ... It just went on for the whole morning. ... sometimes I did not get a response."

HE: "I have been quite busy, I don't respond as much as I should, really. At this time I was working at the van, and spend some time in the office. I was working and trying to fix bits on the van. **I tend to leave messages. Don't ignore them.** When I am in the middle of something I like to finish that thing. Because I can't multitask."



annotated space time diaries

parts of the space-time diary that are relevant for the scenario (annotated by the researcher)

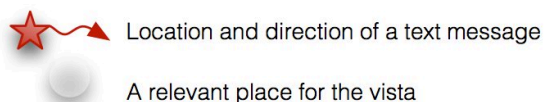
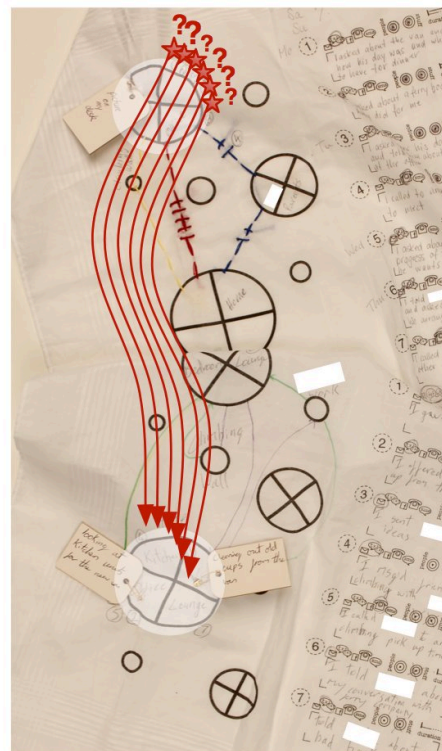


Figure 5.12. Curated Probe of couple MRS4 introducing the instance of mobile interaction trajectories.

Respondents MRS5

<p>General:</p> <p>The respondents are in their early 30ies. They share a flat. They both work in 9 to 5 jobs. He is a lawyer. She is a manager.</p> <p>Time of recording: Spring 2013.</p> <p>Recording duration: They recorded for one week, including the weekend.</p> <p>They were interviewed together.</p> <p>For design workshops, I called them Fred and Wilma.</p>
<p>The interview revealed 6 thematic clusters</p> <ul style="list-style-type: none"> • They reported about her business trip abroad and how they stayed in touch in that period: Text messages during the day and Skype calls in the evening from the hotel. • They discussed about their after work routine. She normally calls him from the car during her homeward trip. • One-off situation: He sent her photo messages from home showing their cat. They were meant as little mood brighteners while she was away for business. • They reported about her weekend trip with her girlfriends during which she updated him constantly using text messages and calls. • They talked about different perceptions of social media and the difference between online and offline communication. • The interview revealed their strategies to manage communication, e.g. his ways to fit mobile communication to his work settings.
<p>Curation criteria: Selected instance of mobile interaction trajectories</p> <p>I presented the Probe with a focus on their communication during her girls' trip to a fashion show. During the trip she was using toilet breaks, time on the car, a short time in the hotel room (etc.) to inform him what she and her friends were doing. However, she did not want her friends to notice, because it was a <i>girls' trip</i> and her friends would complain. This example shows communication taking place over time introducing a certain chronology of mobile communication. The communication appears as structured by the contextual circumstances alongside the person's individual trajectory. This is a core position for mobile interaction trajectories.</p>
<p>Probe use:</p> <p>SHE recorded her weekdays on one space-time diary and her weekend on a separate one. She took the Hankie Probe with her in the beginning, but then left it at home and in the hotel room. At work, she was not able record straight away, due to the office culture. She provided summaries for moments of connectedness during the week, but recorded every communication during the weekend. HE recorded each entry and filled the space-time diary and forms chronologically. He carried the Probe with him in his workbag. He recorded each communication on the spot. They recorded content and context of their communication with keywords.</p>
<p>Fabric and Stitching:</p> <p>SHE: She sewed and commented: "Writing on the hankie was a bit cumbersome".</p> <p>HE: He did not sew and commented: "Writing on the hankie was a bit cumbersome".</p>

Table 5.5: Summary of Probe Respondents MRS5's interview and Probe use

Respondents MRS5's space-time diary

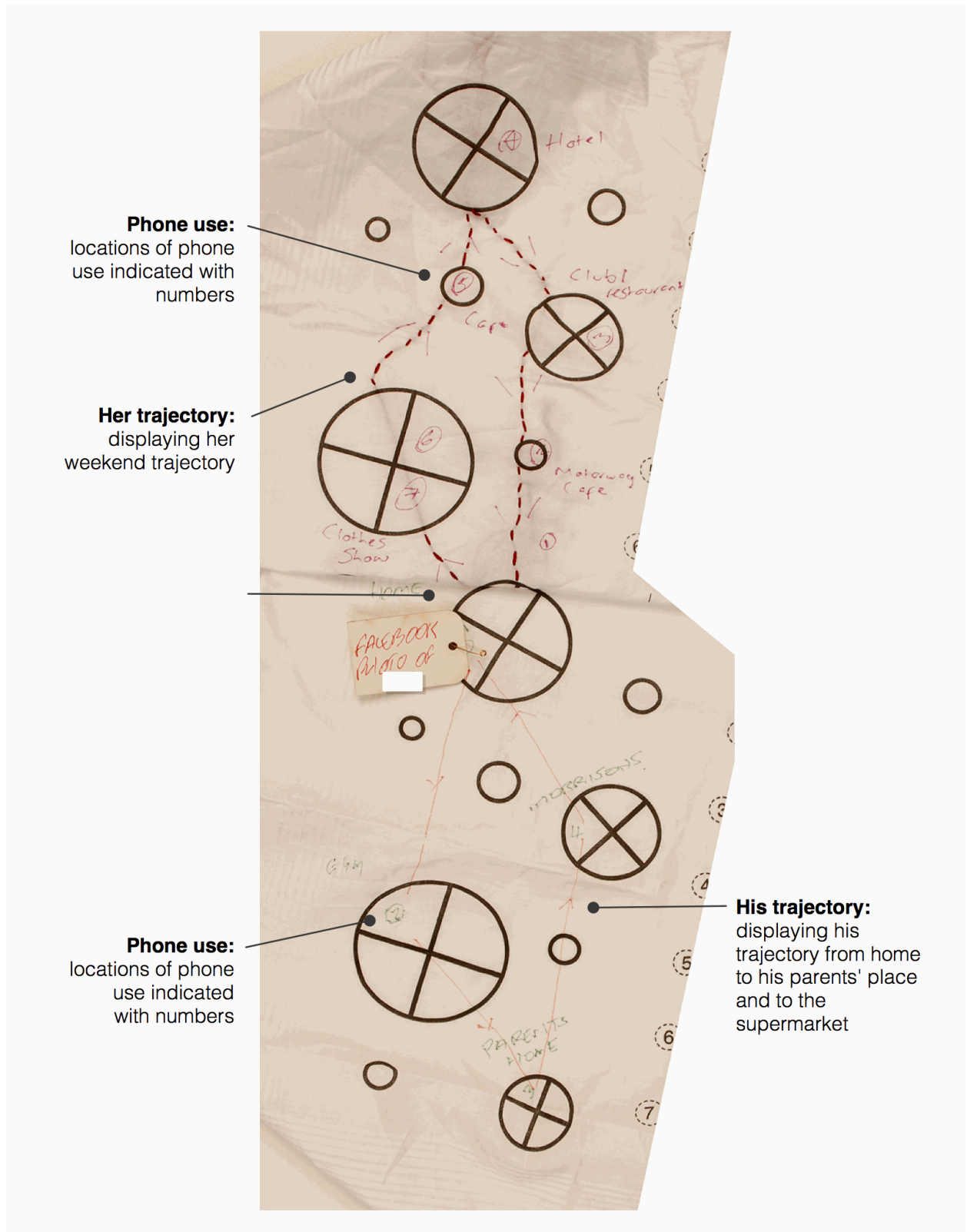


Figure 5.13. Couple MRS5's completed space-time diaries, annotated by the thesis researcher. Two space-time diaries above one another, creating the couple's map of daily trajectories and places..

ensemble 5: I want YOU to be part of it

The Example of Fred and Wilma:

Wilma wishes Fred was there, but it is a girls' trip!

Wilma is on that girls trip with her friends. They go to see a fashion show, have food and go out clubbing. They stay overnight and drive back only the next day. **Wilma wants Fred to be part of this.** She wants him to be aware of what she is doing. She updates continuously. **He has problems catching up with her texts** and only responds to a few,

who they are

Fred and Wilma are a couple in their early 30ies. Although having met not that long ago, they live together in one flat and will get married soon. They are both working at an office. They like to update themselves about what they are doing and how things are, etc. Wilma, it seems, is a bit more active in that respect. Recently, Wilma has been away for work during the week, but returned for the weekends.

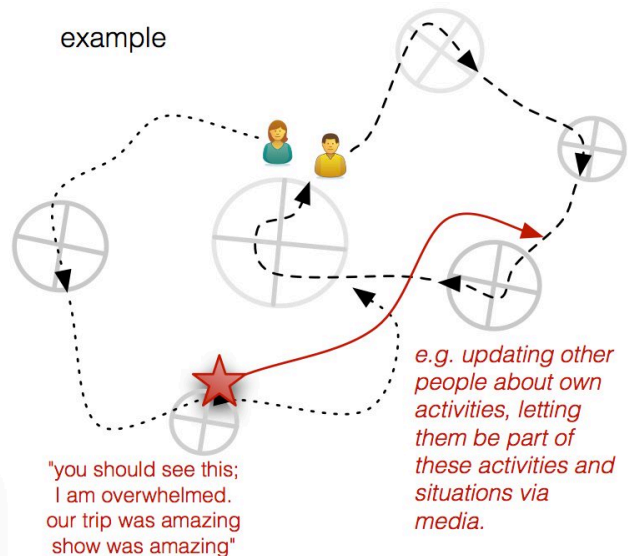
quotes from the interview

SHE: I think its just about awareness, letting each other know what we are doing, ...

- * This one was to tell him that I was on the way to Birmingham, this one is to say I am in the car.
- * I texted from the car and then I rang when I got into the hotel. The was just to say that the hotel was nice.
- * I rang him from the the hotel ... was to say we had arrived and that journey down was quite long.
- * I texted before we went to the pub, told him I would speak to him the next day.
- * At the restaurant I rang him from the toilet. To tell him that I was ok.

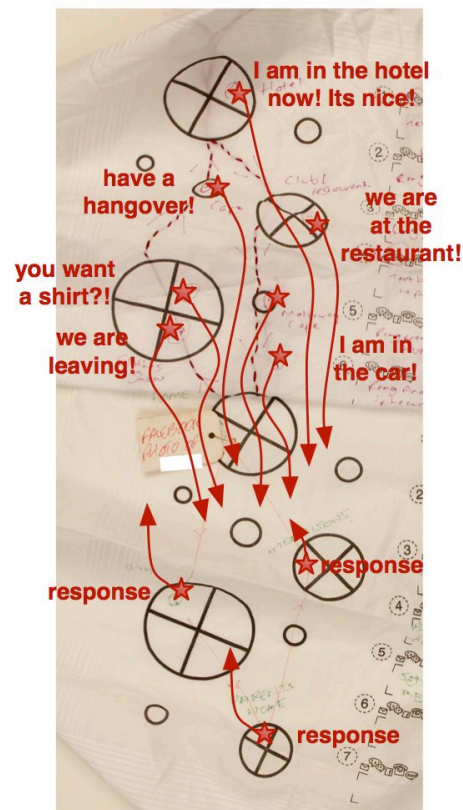
HE: I deal with her texts as soon as I can. when I am not busy. Normally in the car, or whenever I am free... the next available time. It depends on the occasion. Obviously, when no one's around me, I reply straight away.

example



annotated space time diaries

parts of the space-time diary that are relevant for the scenario (annotated by the researcher)



★ → Location and direction of a text message

Figure 5.14. Curated Probe of couple MRS5 introducing the instance of mobile interaction trajectories.

Presentation of completed Probes and annotated space-time diaries of
Probing experiment two:

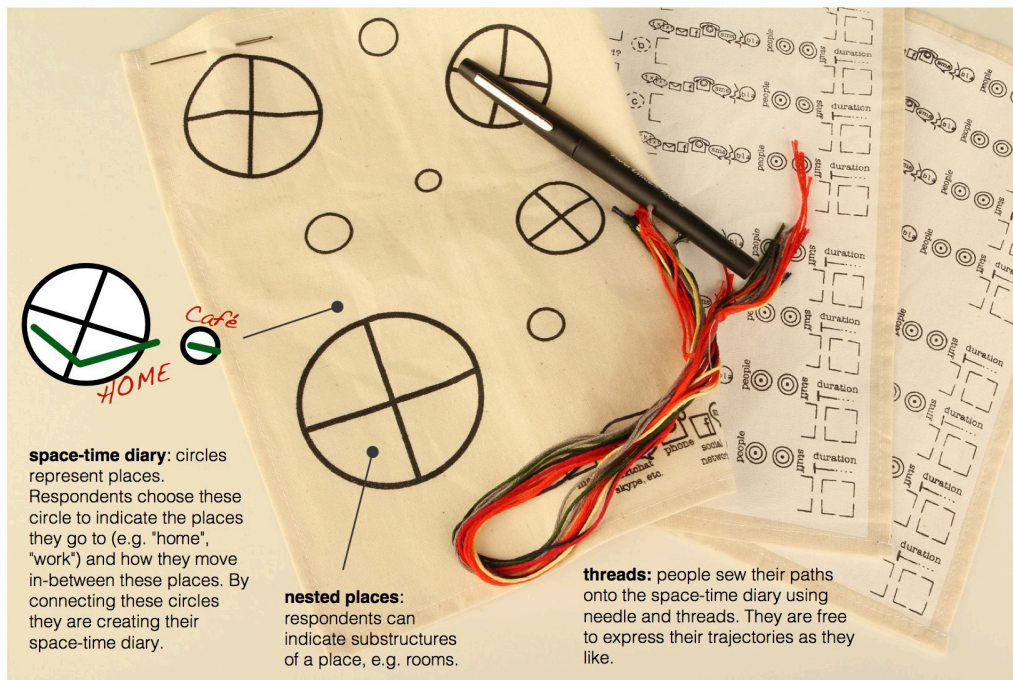
Mobile Work Communication

Completed Probes and their particularities, including short summaries of respondent interviews and the Probes' curation for their presentation in design workshops.

Due to the format of this document, the curated Probes (presenting instances of mobile interaction trajectories) can only be presented in condensed form, introducing each instance's gist. The full version of each curated Probe is documented by Appendix 5.2.

Note: the following completed Hankie Probes focus on the presentation of the space-time diaries. Contextual notes on the completed Probes are not highlighted, but represented by summaries and quotes taken from the debriefing interviews. Full legible versions of each completed Probe including contextual notes can be found in the Appendix 5.5.

The Hankie Probe for Probing experiment two



The figure below shows one 'project sheet'. The participants were to choose which work projects and related communication they would like to track. The aim was to look at the communication of 2 to 4 projects.

context of communication: these notes aim to capture the use context of each communication. People locate their device use on their space-time diary and use the forms on the right side of the hankie space to take notes about the situations they are in when communicating.

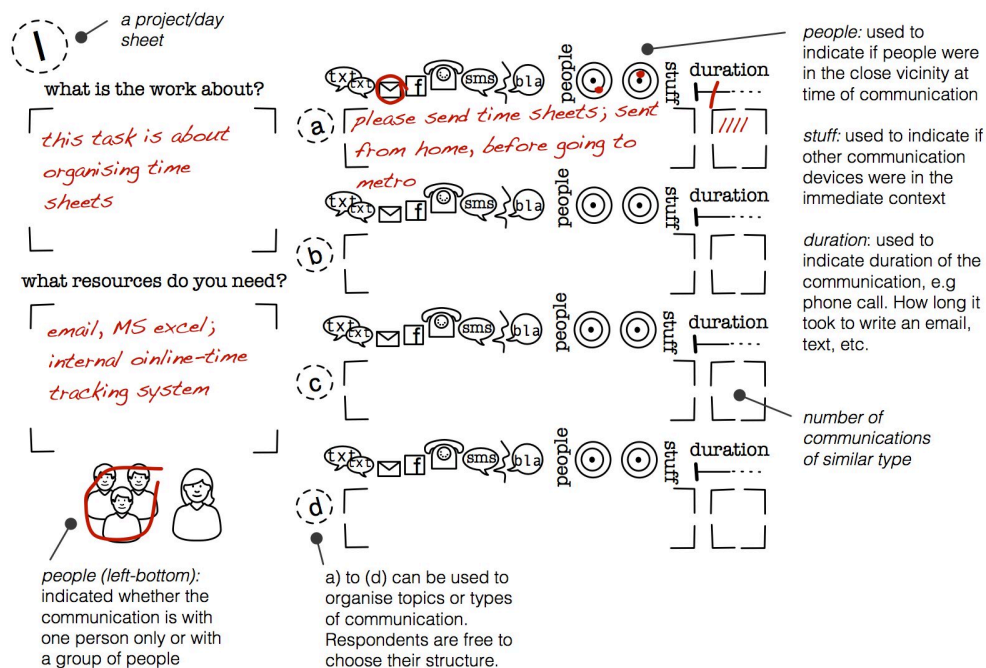


Figure 5.15: Raw Hankie Probe for probing experiment two. The Hankie Probe's core concept was appropriated for capturing respondents' work communication. A legend printed on the hankie explained the communication icons ('txt', 'sms', etc.). Furthermore, respondents received a summary of instructions with the Probe package.

Making and Testing

I conducted a test run tracking my own trajectories and work communication for one week. This helped to re-design the Hankie Probe for probing experiment two. After the test run, I re-designed the forms for contextual notes slightly.

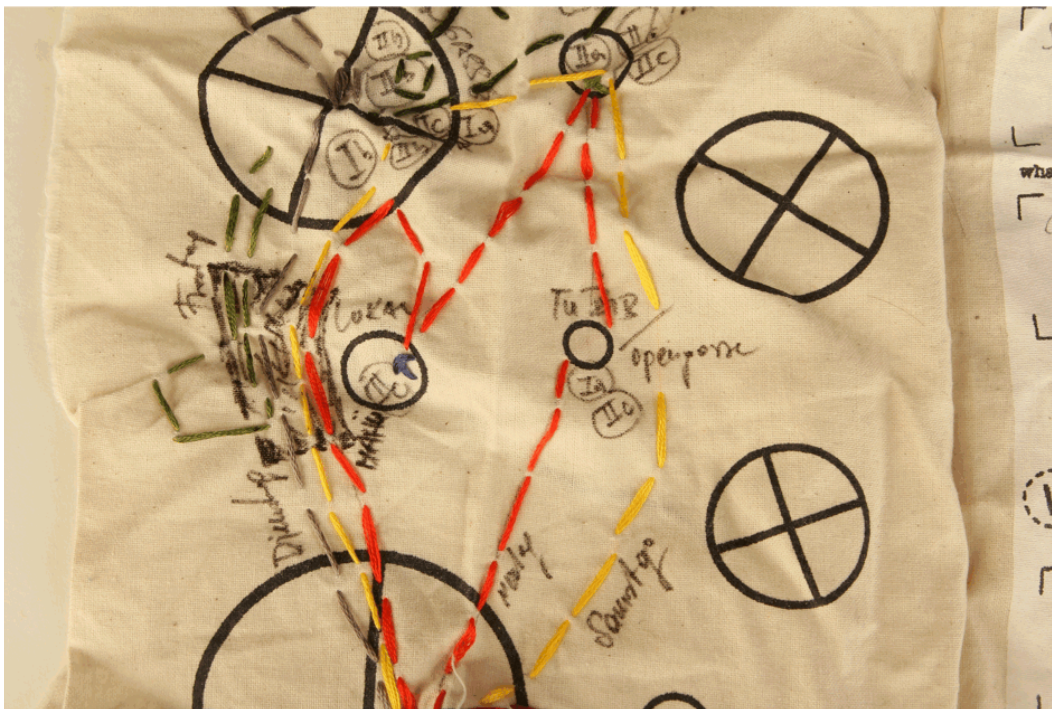
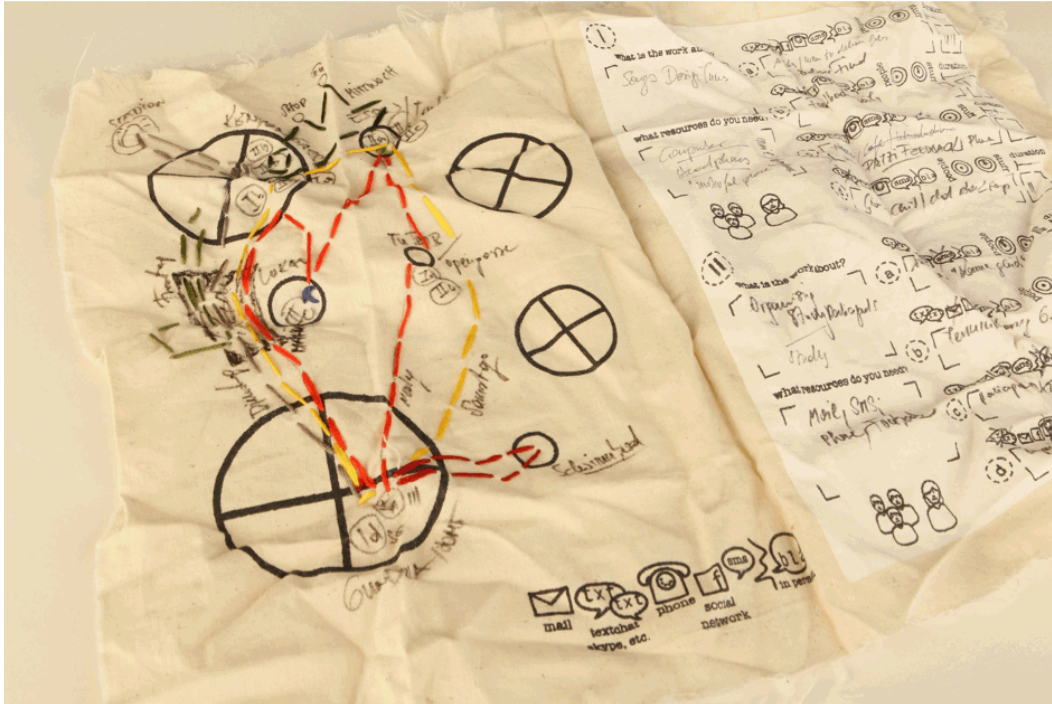


Figure 5.16: Results of self-trails with an early version of the Hankie Probe for probing experiment two.

Introducing the Probes to Probe Participants

The Probe was introduced to the respondents personally in form of Probe packages as shown below.

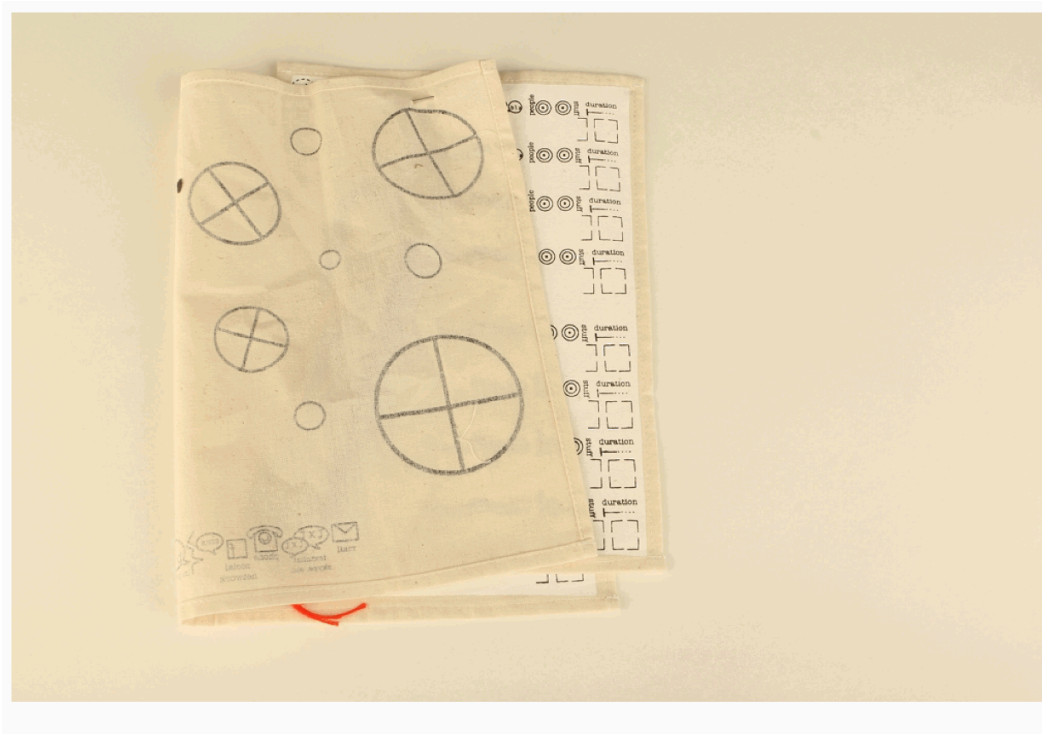


Figure 5.17: Example Probe Packages as handed over to Probe respondents MWC1 to MWC5

Respondents were introduced to the Probe individually. Each introduction session lasted for 30 minutes. The core concept of the Hankie Probe were explained to the respondents. I described how to understand and use the space-time diary and how to record contextual notes.

Respondents were told to indicate their trajectories either by pen or with the provided embroidery tools. It was left to them how exactly they wanted to express their space-time diaries. Respondents were told that their recordings are the basis for a debriefing interview.

I suggested recording as soon as possible after each communication, but explained that recording on the spot was not necessary. I also suggested carrying the Probe with them.

Respondent MWC1

<p>General:</p> <p>Respondent MWC1 is an art and radio journalist.</p> <p>Time of recording: Spring 2012.</p> <p>Recording duration: She recorded for one workweek (5 days of work).</p> <p>For the presentation of MWC1's Probe in the design workshops, I named the character Margarete.</p>
<p>The interview revealed 6 thematic clusters</p> <ul style="list-style-type: none"> • Her home office is the most valuable context for work and communication • During workdays she experiences a flow of information in the background: incoming email is visible to her, but she does not attend to each one immediately. She catches up with emails later in the evening. • She depends on offline AND online communication. Her work requires face-to-face meetings. • Online communication is used for instigating offline communication, e.g. asking people to meet. • She uses emails to wrap up offline communication, e.g. for protocols of meetings and chats.
<p>Curation criteria: Selected instance of mobile interaction trajectories</p> <p>The role of MWC1's private office was essential. It is a significant place for MWC1 helping her to get things done and to communicate effectively. During the day, she keeps emails for later in the evening, and responds to mail when she is back at her private home office. This necessity to be in a certain place, being physically immobile, to be able to follow up mediated communication, as well as the idea of a structured communication routine, which is organised around one particular place, is a good instance of a mobile interaction trajectory.</p>
<p>Probe use:</p> <p>She indicated her paths and her communication as connections between the places on the space-time diary. She added a date for each of her trajectories on the map. She did not indicate every single communication on the space-time diary, but provided summaries of communications ordered by the media she uses via contextual notes. She recorded in the evening, based on her diary and communication history (on different devices).</p>
<p>Fabric and Stitching:</p> <p>She refrained from stitching and drew her space-time diary using a standard pen.</p>

Table 5.6: Summary of Probe Respondents MWC1's interview and Probe use

Respondents MWC1's space-time diary

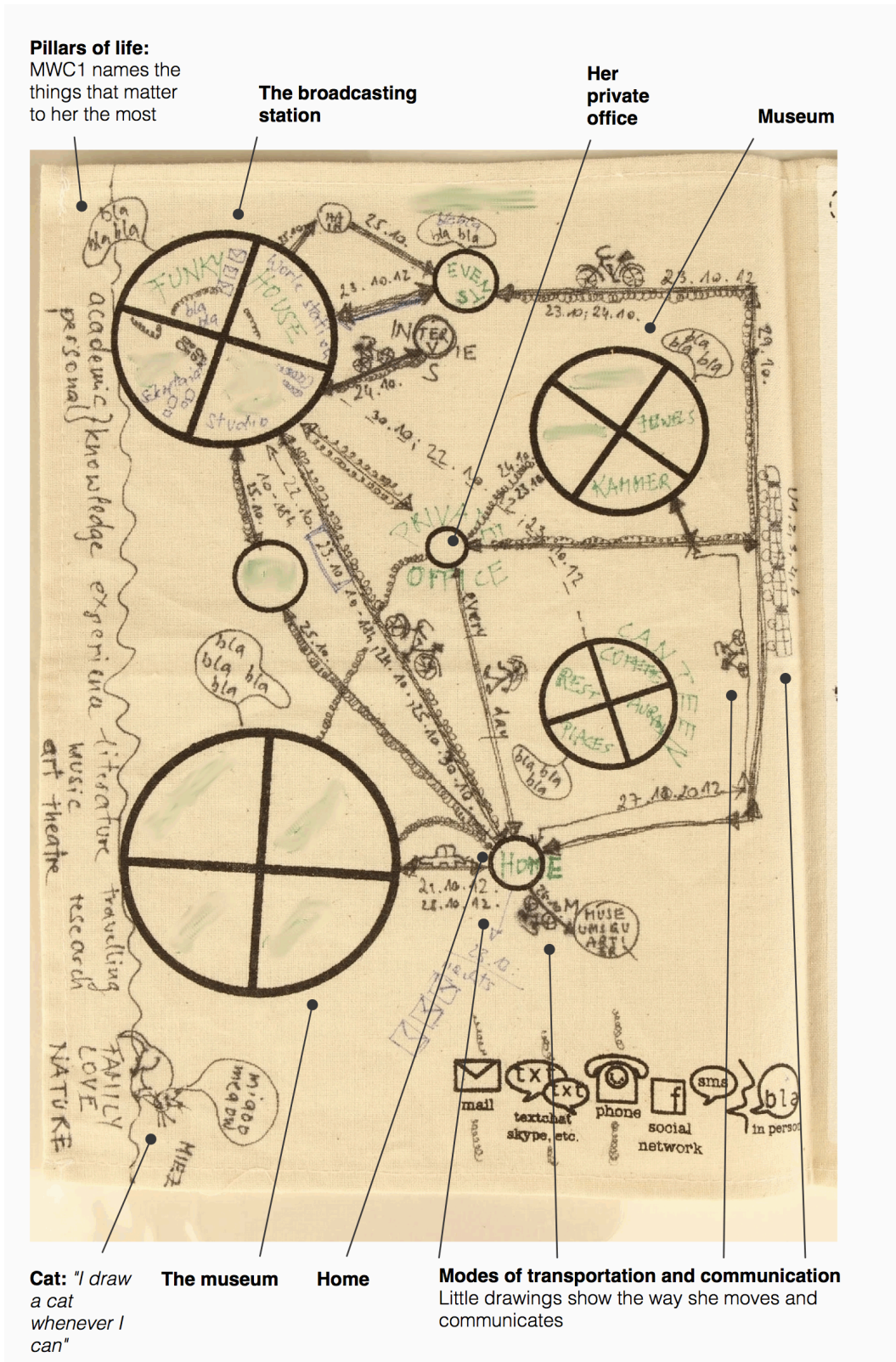


Figure 5.18. MWC1's completed space-time diary, annotated by the thesis researcher.

mobile work strategy: from oasis to oasis

The Example of Margarete: the perfect communication hub

For her work she roams in-between different places. While the phone and email are important resources for her work, she needs a certain zone to use them effectively. **The most valuable place is her private office.** There she is cut off from any immediate influences (other people, other work, etc.). In other places she is only reacting to important mail.

who she is

For Margarete, who is a freelancer, work is an integral part of her life, even the busy parts of her two jobs. She says her work as a journalist gets her in contact with interesting people from all over the world, who have different backgrounds and expertise. She enjoys that.

For her programs she works and researches on different topics, which she thrives from. She feels like growing her personality through work.

quotes from the interview

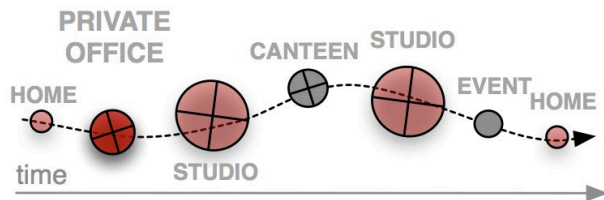
SHE: There are paths which I am doing regularly. I walk from my flat over to my office. This one I do everyday. This is in the same house, on the same storey. I walk back and forth between these two places. Thats the first and most important path.

At home I have only a few job-related calls. There is my husband, the cleaning lady, the kids in case they are home. There are the cats. But in general I need resources (note: for job related stuff). I need to look up things in notes and papers, look at my calendar, I need to do some research on the internet.

We have these outlook programs, so you get the header and the first line of this mail at the bottom of the screen. Depending on that I can decide, do I open it right away, or do I keep it for later.

I returned back home, and late at night I wrote many mails and looked at mails. These concerned the production, but also from the customer department, cause I could not catch up with all these things during the day. So I pushed it back till later that day.

example/abstraction



being in more or less favourable contexts for mediated communication

annotated space time diary parts of the space-time diary that are relevant for the scenario (annotated by the researcher)

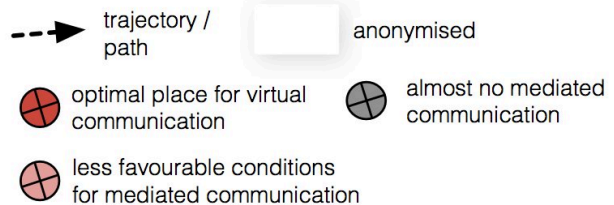
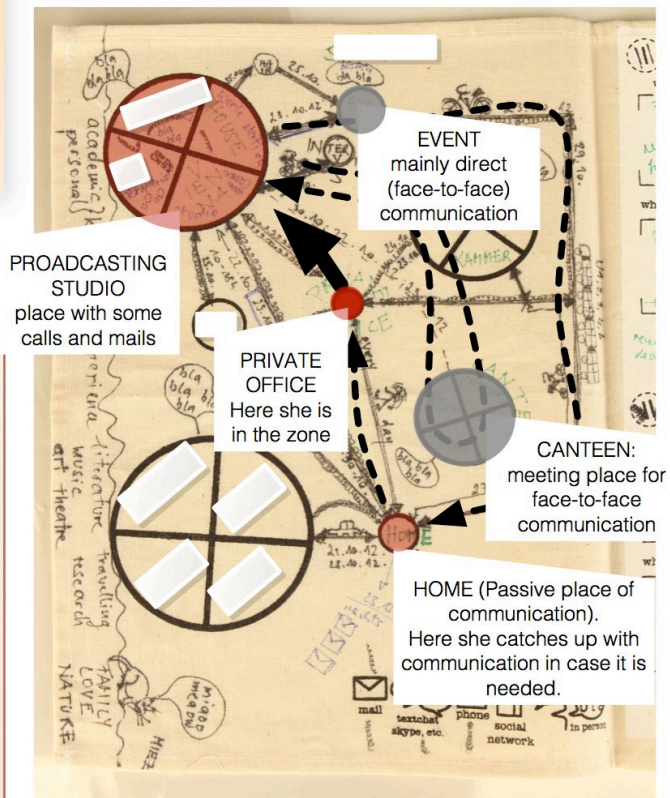


Figure 5.19. MWC1's curated Probe introducing the instance of mobile interaction trajectories.

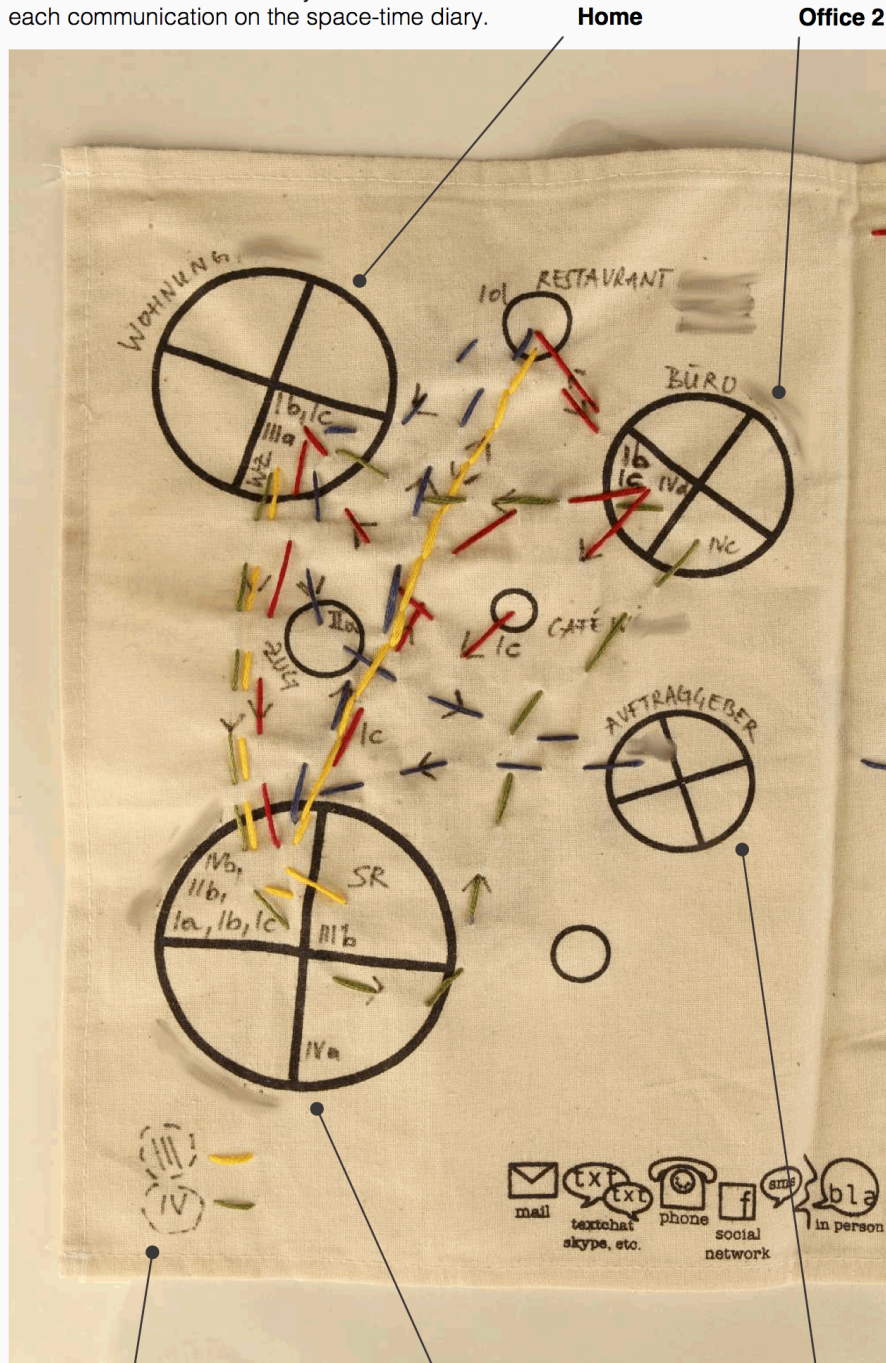
Respondent MWC2

<p>General:</p> <p>Respondents 2 is a professor of university and a company owner.</p> <p>Time of recording: Spring 2012.</p> <p>Recording duration: She recorded one workweek (4 workdays).</p> <p>For the presentation of MWC2's Probe in the design workshops, I named the character Hillary.</p>
<p>The interview revealed 6 thematic clusters</p> <ul style="list-style-type: none"> • She has no communication when she travels, but she is waiting for times when she can receive information, e.g. via email in train stations, etc. • She accounts for and appreciates times when she is cut-off from communication channels. It has a certain quality to her. • Managing communication: She has a structured approach to deal with emails. She organises emails according to projects. She focuses only on the relevant communication for the project she is working on. This strategy breaks down when urgent things require her attention. • There are only a few situations/tasks for which she shuts-off all communication channels, e.g. when doing the accounting or during exams at university. • Reflection on media: She sees disadvantages of SMS for business use, because <i>multiple receiver</i> functions such as .cc are not available to her, and typing long text messages on the phone is cumbersome.
<p>Curation criteria: Selected instance of mobile interaction trajectories</p> <p>This curated Probe was focused on the respondent's desire to keep work communication ordered. The respondent is involved in several projects, works from different places and goes to client meetings on a regular basis. Her desire and approach to keep communication practices in order seemed to be a worthwhile focus for design workshops. The respondent's approach of walking back and forth between offices and structuring communication according to the places she works from is a good example of a mobile interaction trajectory. It shows that mediated communication is related to particular places during people's trajectories with changing states of connectedness.</p>
<p>Probe use:</p> <p>She recorded one workweek (4 days + one bank holiday). She did chronological recording of each day indicating communications alongside her trajectory. She recorded each day in the evening (contextual notes) and stitched the space-time diary at the end of the week. She also provided communication summaries with the contextual note forms.</p>
<p>Fabric and Stitching:</p> <p>She used one coloured path for each day she recorded. She experienced the use of needles and threads as a relaxing activity, putting her into a reflective mode: "The recall is more intense."</p>

Table 5.7: Summary of Probe Respondents MWC2's interview and Probe use

Respondents MWC2's space-time diary

Ordered appearance: MWC2 used one coloured thread for each day. She noted down each communication on the space-time diary.



Legend: The well ordered appearance is supported by a legend. It links the stitching to contextual notes

Figure 5.20. MWC2's completed space-time diary, annotated by the thesis researcher.

mobile work strategy: managing contextual involvement

The Example of Hillary: keeping work communication ordered

Hillary is a professor at university and also runs a company. She has got two offices, one for each job, which are both located close to each other. Only a few minutes walk separate the two. She actively manages her mediated involvement in ongoing projects. She does not look at her university mails when she is at the company office and vice versa.

who she is

Hillary is a busy lady. She says that she hasn't got a very set structure for managing university and company projects. However, she tries to keep things ordered and deals with urgent matters as they emerge.

Only sometimes she experiences being cut-off from communication channels. She perceives this time as special, it has a certain quality to her.

quotes from the interview

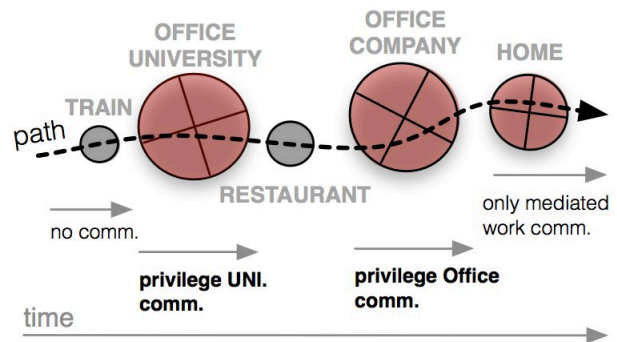
SHE: "when I plan to be at Uni I don't even open my mails for the office, or vice versa. So, I have a conscious separation. So... I access the office mail address being at the company office and at home But the separation does not make sense sometimes."

*For example the telephone works poorly in the train and I make less phone calls, so: it is quiet. This means: I do less communication on the train, and I tend to work on the actual projects more. When I reach a bigger city I look-up my mails again, there I can assume the internet is not overly slow and dull. **I think it has a certain quality** [note: to be offline for some time].*

*Apart from the situations when I would need a face-to-face meeting I think it is pretty much the same. **It does not matter whether I respond to an email sitting in Germany or somewhere else.***

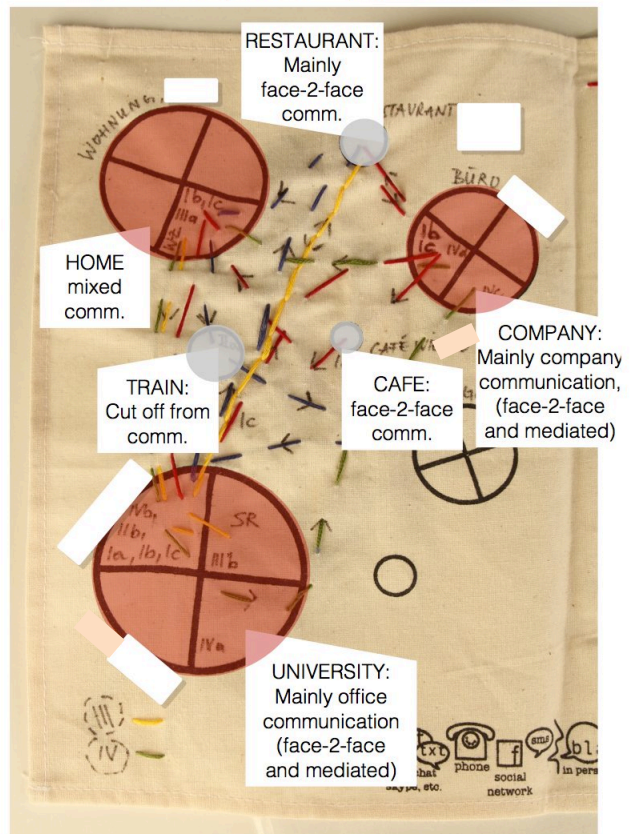
No, that does not bother me. In the office and at the uni I don't have an office just for myself, even if I am the boss, I think I need that... the people. It is nice to have someone around, who one can ask about ongoing stuff 'what do you think, how does that work?'

example/abstraction



managing the time and amount of mediated communication over the course of a day

annotated space time diary parts of the space-time diary that are relevant for the scenario (annotated by the researcher)



- a place with mediated communication
- a place with no or little mediated communication
- anonymised

Figure 5.21. MWC2's curated Probe introducing the instance of mobile interaction trajectories.

Respondent MWC3

<p>General:</p> <p>Respondent 3 is a service manager. He manages several elevators and service technicians. He is the point of contact for existing and new clients.</p> <p>Time of recording: Autumn 2012.</p> <p>Recording duration: He recorded one workweek.</p> <p>For the presentation of MWC3's Probe in the design workshops, I named the character Werner.</p>
<p>The interview revealed 5 thematic clusters</p> <ul style="list-style-type: none"> • He tries to leave work at the office. He turns off the phone when he parks the car at home. • His communication with clients is sometimes unpleasant. It requires politeness anytime; mail communication is therefore easier to handle, because it is less direct. • Some of his communication works purely via phone. This mainly concerns the contact with his service technicians out in the field. • His communication often needs to be in email format to have written proof of what was said. • Some communication needs to be face-to-face, e.g. important client meetings. <p>He needs face-to-face meetings to discuss and arrange documents for project proposals and contracts.</p>
<p>Curation criteria: Selected instance of mobile interaction trajectories</p> <p>For the presentation of this Probe, I decided to focus on the Probe respondent's strict approach to separate work from private life. In addition, the curated Probe emphasises his communication with clients. This is sometimes problematic, leaving a negative experience: they contact him to report errors and to complain. This explains his desire to shield off such communication as much as possible. This is why he prefers to communicate with email, although it is a source of misunderstandings. It is less direct. He is less exposed to client's emotions.</p> <p>This instance features one place for mediated communication as part of an everyday trajectory: his office. Further, the instance emphasises particular media choices for being connected. These particular choices, as part of everyday trajectories, make a good example of mobile interaction trajectories.</p>
<p>Probe use:</p> <p>One week of recording. He colour-copied the fabric space-time diary and left the fabric untouched. He took the colour copy with him. He used a ruler to indicate paths in-between places and used a black pen for all entries. He indicated summaries for some types of communication, e.g. of some emails and phone calls relating to one topic. He provided a small number of keywords to describe the content and context of communications.</p>
<p>Fabric and Stitching:</p> <p>He recorded contextual aspects, but started a new copy after a while to rearrange his entries. He re-drew the space-time before the interview. He photocopied the fabric and only used a space-time diary's paper version.</p>

Table 5.8: Summary of Probe Respondent MWC3's interview and Probe use

Respondents MWC3's space-time diary

Paper copy of the hankie:

MWC3 used a photocopy of the fabric-based Hankie Probe. He did not want to use the fabric. He thought it was a one off piece.

Phone use:

numbers indicate locations of communication

Clients construction site

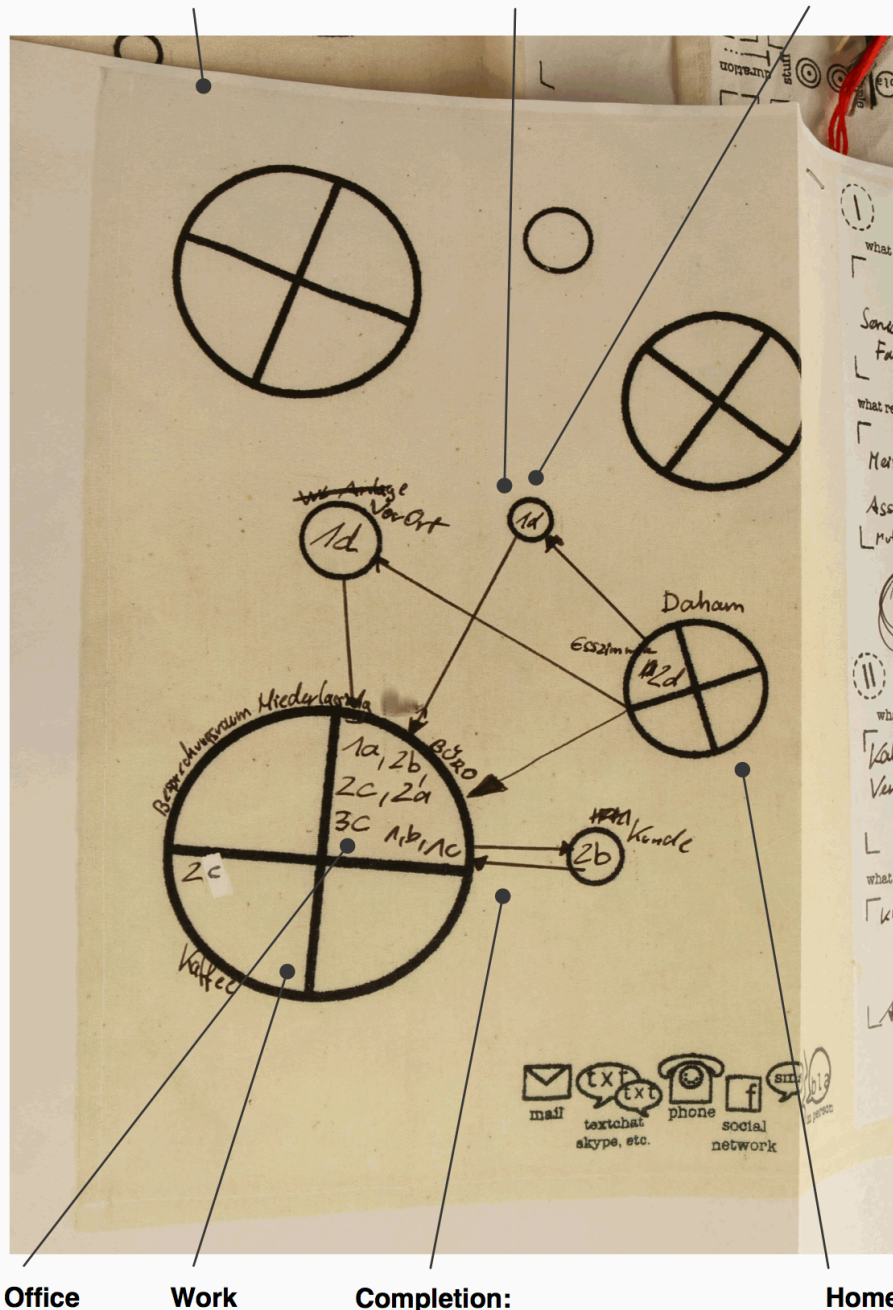


Figure 5.22. Probe respondent MWC3's completed space-time diaries, annotated by the thesis researcher.

mobile work strategy: fending off communication

The Example of Werner: keep work involvement restricted

Werner works as a service manager. He looks after 1000s of elevators, manages their servicing and the related contractual issues. In his position, clients usually call to complain, to report issues with an invoice or an elevator. Every once in a while one even shouts at him on the phone. **He tries to keep work at the office.**

In general he prefers talking to customers as it allows him to understand them better and he is able to guide the conversation. **Email is a source of misunderstandings.**

who he is

Werner is a highly professional guy, who takes his work very seriously. He tries to be correct with his clients and up-to-date in dealing with their issues and requests. He wants his clients to be satisfied.

He says he is up-to-date with his work and he is proud that there are no complaints about him.

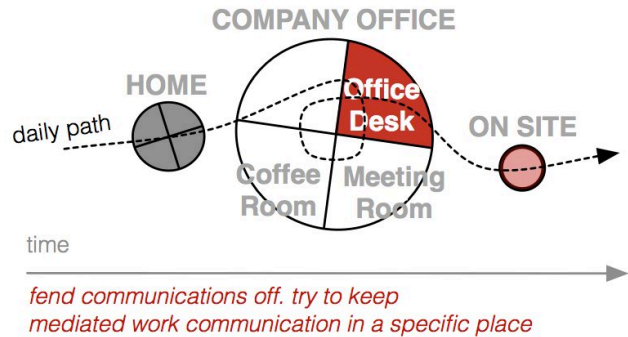
quotes from the interview

HE: If you listen to the client and if you give him the feeling that you understand what he is saying, or if you are able to present him a solution, maybe, then these phone calls turn out to be gentle, in the first minute he is harsh, in the second he is normal, and in the 3rd he is nice. It really depends on how I react.

*But the most important thing is always: in case I am stressed... me personally, sad, angry, or so, then I don't have to pick the phone. I will always call them back within 24 hours. But the most important things is to listen to the people, let them talk, let them feel that you understand them. **With mails you don't have that, exactly, with mail you spear yourself form listening...***

I educate my clients. My clients have never complaint, and they won't. ... I turn of my phone off when I step out of my car in the evening [note: at home]. I turn off my company phone

example/abstraction



annotated space time diary
parts of the space-time diary that are relevant for the scenario (annotated by the researcher)

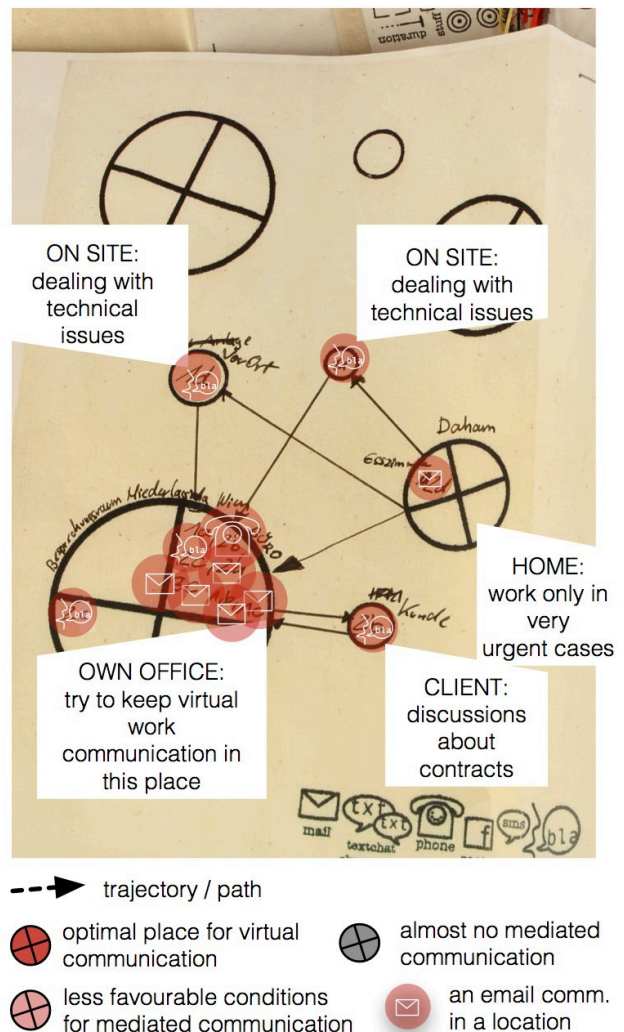


Figure 5.23. MWC3's curated Probe introducing the instance of mobile interaction trajectories.

Respondent MWC4

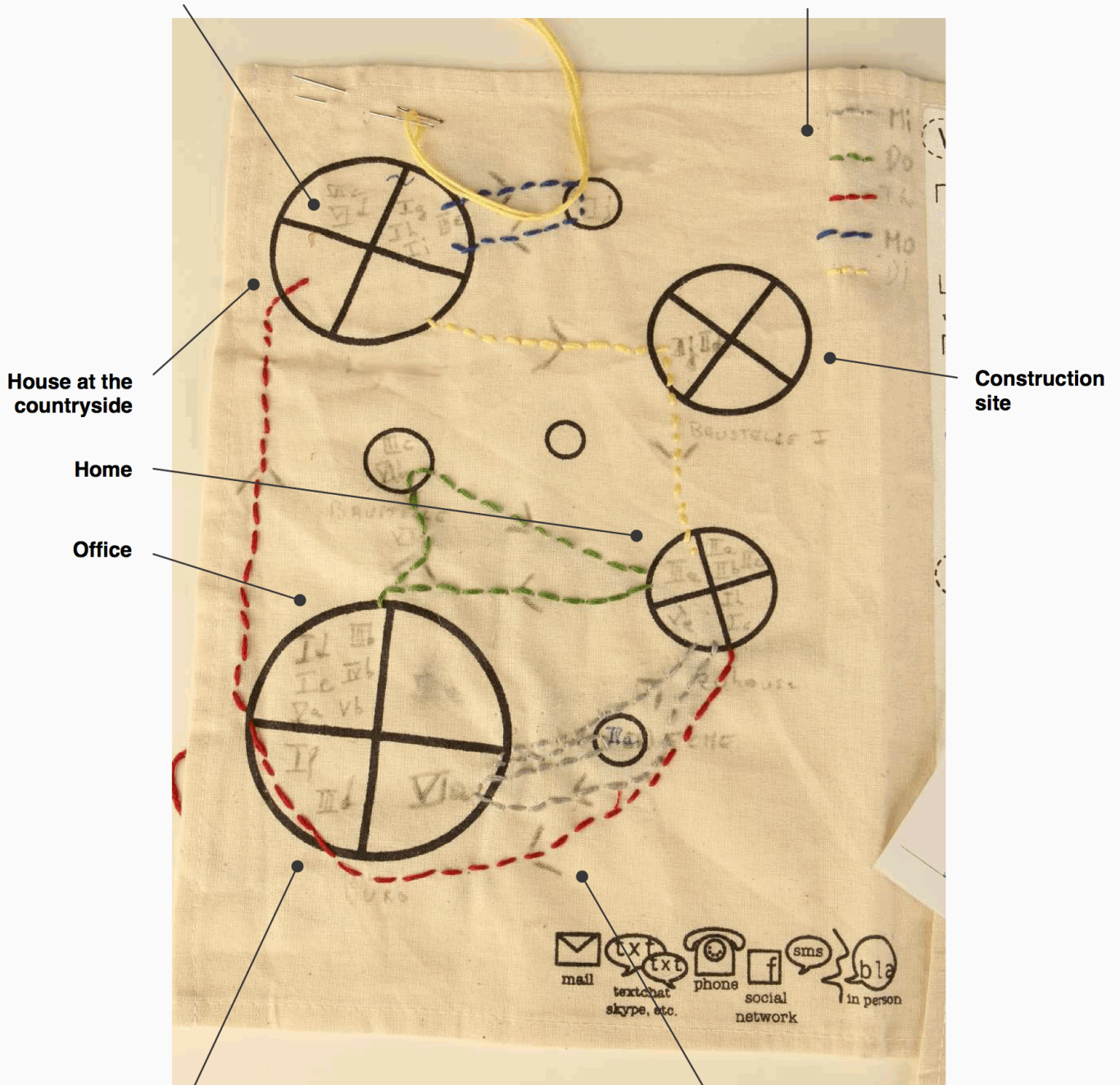
General:
<p>MWC4 is a company owner working in the area of landscape planning. He works on several projects simultaneously and changes work location regularly. His schedule depends on projects and site visits. He works from home, his office and from his house at the countryside.</p> <p>Time of recording: Autumn 2012. Recording duration: 5 workdays, starting from Wednesday to Tuesday. For the scenario presentation I called him Sisyphus.</p>
The interview revealed 7 thematic clusters
<ul style="list-style-type: none"> • Mobilisation of content. He has all necessary documents and work infrastructure on his laptop computer. This allows him to work from 3 different places. • Discussing one topic, his communications with clients and colleagues last for several days, spreading across several places of everyday life. • Communication pattern: He requires several communication attempts to obtain one piece of information from people he works with. Often starting with email, but ending with phone calls to receive attention. • His office is a place to communicate, but not to work. For him, office environments make it impossible to work on a report (or similar). • He has communication rules: email should always have a personal note and weekends are a no-communication period. He does not send emails on Saturdays or Sundays. • He thinks that people deal with emails like they deal with letters: they store it in a pile and look at it eventually. • Being the company's CEO, there is a need for face-to-face meetings with clients: This is required for getting a better sense about how projects are progressing.
Curation criteria: Selected instance of mobile interaction trajectories
<p>The presentation of the curated Probe focused on MWC4' disappointing email experience. His space-time diary shows several communications referring to one piece of information he was waiting to receive. In the beginning, he sent emails asking for particular documents, but only received them when phoning the person in charge. This example offers a focus looking at different impact-levels of mediated communication. Combined with the respondent's repetitive communication attempts during his individual trajectory, this instance forms a good example of mobile interaction trajectories.</p>
Probe use:
<p>He recorded each day's trajectory with a different colour. He indicated the location of each communication on the space-time diary and provided short summaries as contextual notes. He took the space-time diary with him the entire week, but did not record straight away. Instead he took notes in a notebook and in an MS excel file, transferring his notes to the space-time diary at the end of the recording week.</p>
Fabric and Stitching:
<p>In the introduction session he declined the embroidery tools. He nevertheless returned the completed Probe with an embroidered space-time diary. He photocopied the fabric and only used the paper version of contextual notes.</p>

Table 5.9: Summary of Probe Respondent MWC4's interview and Probe use

Respondents MWC4's space-time diary

All communication entries:
MWC4 indicated all his communications on the space time diary

Legend: He split up his recordings by days and indicated each weekday with a different colour.



Passing by a place:
MWC4 indicated to have passed by his office on his way to his house at the countryside.

Direction: MWC4 added arrows to his paths to indicate the direction of his trajectories.

Figure 5.24. Probe respondent MWC4's completed space-time diaries, annotated by the thesis researcher.

mobile work strategy: tenacious communication

The Example of Sisyphus: trying to get hold of information

Sisyphus is the owner of a company, which is quite loosely organised. There is an office, but colleagues and himself work from home or from other places and show up in the office on agreed times for meetings.

He has problems collecting information. It costs him time and effort to get hold of documents he needs to screen, work and finalise. In that respect **he has the feeling of wasting time on communication** as he has to email and call several times in order to get the files he needs. **He feels like being in an inefficient loop of communication**

who he is

Sisyphus wants communication to be personal. He dislikes automated messages of receipt. He likes to add personal comments to every mail.

He feels like he is not able to work on a project or report in the office. In this place, he feels like being interrupted every 10 to 15 minutes.

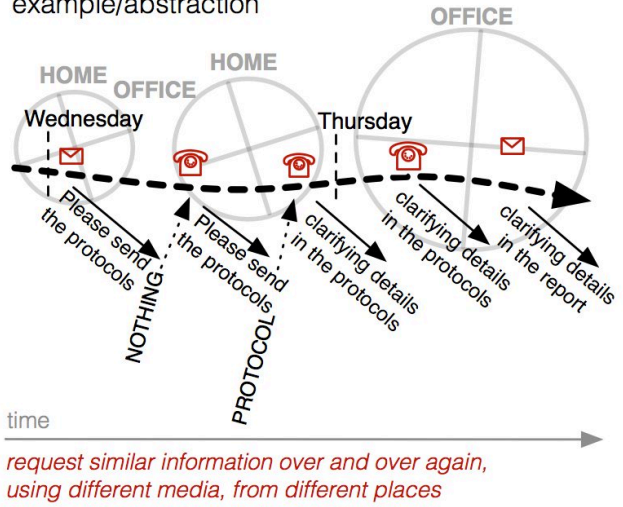
quotes from the interview

*He: There was a mail and a call. I think that happens quite often. I realised that. It is an absurd approach to it. I send an email and I don't receive an answer. What happens? I call them to ask: "What happened to my mail?". [...] They said: "I will send it back to you soon". But I said I would meet them soon anyway, so that we could talk in person. So there are three actions for one thing to happen. **This annoyed me, cause it was the first time I took notice.***

This was funny, because I was not aware of that. This sequence can be improved. Not only with clients, also with my co-workers. In general, when I send an mail I start to wait.

With emails a behaviour comes into play that has been 'rehearsed' with traditional mail over decades. It's like that: One walks over to the mail box [note: physical mail], empties it and says: 'Aha. there is plenty of it.' One puts it aside, but only eventually one opens this mail and then scans the content.

example/abstraction



annotated space time diary parts of the space-time diary that are relevant for the scenario (annotated by the researcher)

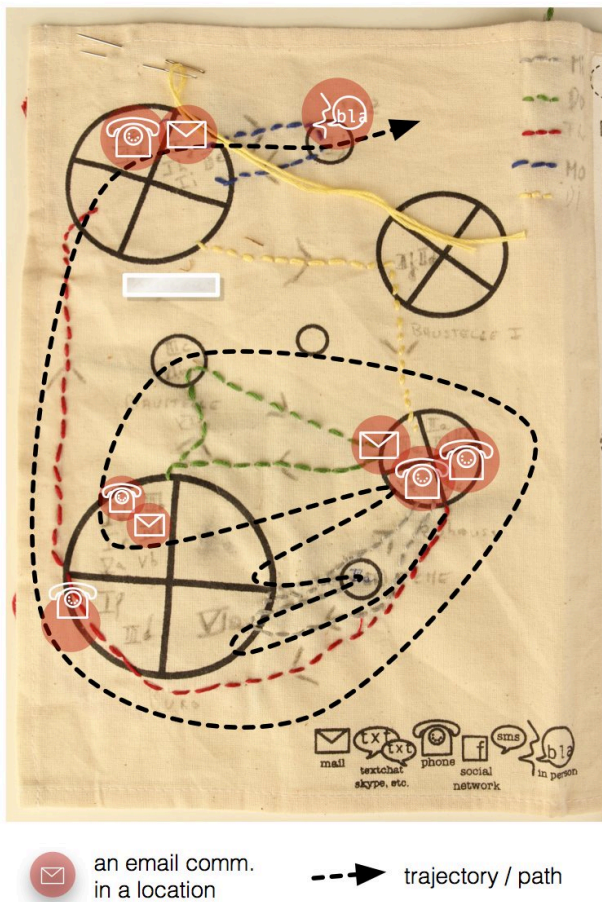


Figure 5.25. MWC4's curated Probe introducing the instance of mobile interaction trajectories.

Respondent MWC5

General:
<p>Respondent MWC5 works in architecture. He prepares civic participation processes and the required legal documentation for housing projects. He communicates back to architects and planning teams.</p> <p>Time of recording: Autumn 2012.</p> <p>Recording duration: He recorded one week of work communication.</p> <p>For the presentation to design teams I called MWC5 Nils.</p>
The interview revealed 7 thematic clusters
<ul style="list-style-type: none"> • He attends to incoming documents and emails immediately, interrupting other tasks he is working on. • He works in a busy office with a few formal but many informal meetings. He walks around in the office consulting people in face-to-face ad hoc meetings. He says that he got used to the general busyness and contextual noise. • Emails are mainly used with groups of externals and internals to maintain a high information level. Sending emails to colleagues in the office is looked down upon. People prefer face-to-face communication. • On-site visits. They are a way to understand the site better, and the drives to these sites are nice and relieving escapes from the busy office. • The industry he works in still relies on traditional means of communication. Phone and email are standard. There are hardly any mobile devices in use, e.g. for emails. • However, his projects involve different media: email, phone, face-to-face, fax and traditional mail for communicating with future tenants.
Curation criteria: Selected instance of mobile interaction trajectories
<p>The most prominent theme was MWC5's site visits that he experiences as relieving escapes from the busy office. He carefully plans these journeys in order to get away from the office regularly. During these visits/periods he is not connected and rarely uses his phone. He is cut-off from communication channels, which introduces different states of connectedness during his day. This 'offline time' is an essential part of his mobile interaction trajectories, where one can distinguish between periods of connectedness and disconnectedness. Physical movement structures his connectedness.</p>
Hankie use:
<p>He recorded one week. He indicated paths relating to his work, but not to and from home. He recorded days chronologically. Each site visit, one a day, is indicated with a different colour). He did not record every communication and did not locate communications on the space-time diary. He provided a summary of his work communication, including notes on content and context.</p>
Fabric and Stitching:
<p>He kept the space-time diary in his bag. He did one recording mid week and one at the end of the week, based on notes and his email inbox.</p> <p>He stitched paths. Each visit to a construction site is in a different colour. He stitched the space-time diary at the end of the recording week.</p>

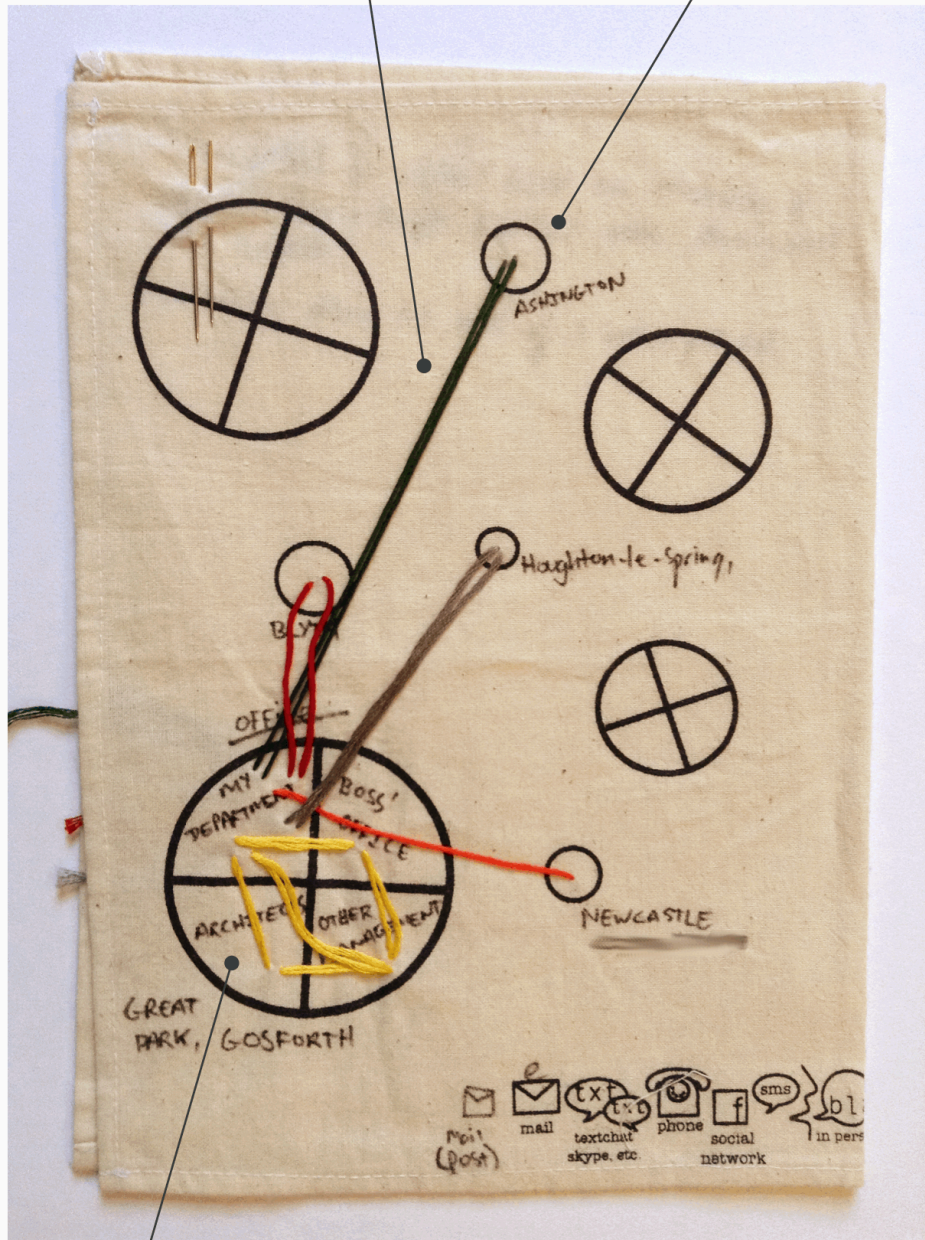
Table 5.10: Summary of Probe Respondent MWC5's interview and Probe use

Respondents MWC5's space-time diary

Long journeys:

MWC5 indicated his drives to construction sites with long stitches. His journeys lasted for approximately one hour each way.

Construction sites



Busy place:

A stitched trapeze indicates busyness. He is walking back and forth to meet co-workers

Figure 5.26. Probe respondent MWC5's completed space-time diaries, annotated by the thesis researcher.

mobile work strategy: to the peaceful island and back

The Example of Nils H.: *planned escapes from busy office*

Nils works in quite a busy office. He manages house building projects together with architects and engineers. Most of the communication happens offline and face-to-face, emails are sent only if a group of people (internals and externals, or both) need to be updated.

He likes escaping the office and leave the hustle and bustle behind. He does so in form of on-site visits. During these visits he is rarely in contact with clients or colleagues. He plans these visits in a way that they split-up his day.

who he is

Nils works in an office where he is responsible for getting new projects started. He plans housing areas. He is the project manager. He is relatively new to the company and wants to do well. This is why he is quite committed to work.

He plans his day, but disrupts his workflow if mails reach him that need immediate attention. In his office he is almost trapped at his desk. He runs one of these old computers and hasn't got a laptop, nor a mobile phone for work.

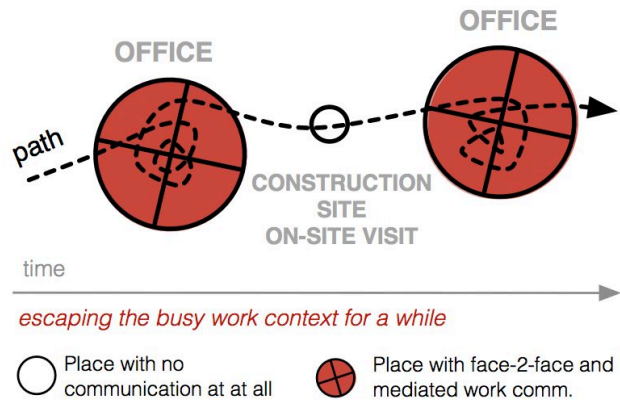
quotes from the interview

He: ...when you wanna ring someone you ring someone, things you don't realise, you learn to keep it as a background noise. But you just learn to knock it out. But it is not really an issue. If you need to speak to someone you speak to someone, if you need to bring someone in the office to have a chat, you bring him in...

Interviewer: How do you feel about going out to these **on-site trips**?

HE: **I like it. It is good, I try to use it.** For example if I had a day were I had a meeting, I try not to go on site, I try to save it for a day where I have got nothing on, I am just gonna be sat in the office all day, so I try to go on-site. I am getting in the car, put some music on, takes an hour or so to get there, then you can have a little walk round. It is that quiet, that peaceful, and then another drive back, by that time 2 or 3 hours have passed, normally its quite good, **its quite a nice break from work and from the rush at the office**

example/abstraction



annotated space time diary parts of the space-time diary that are relevant for the scenario (annotated by the researcher)

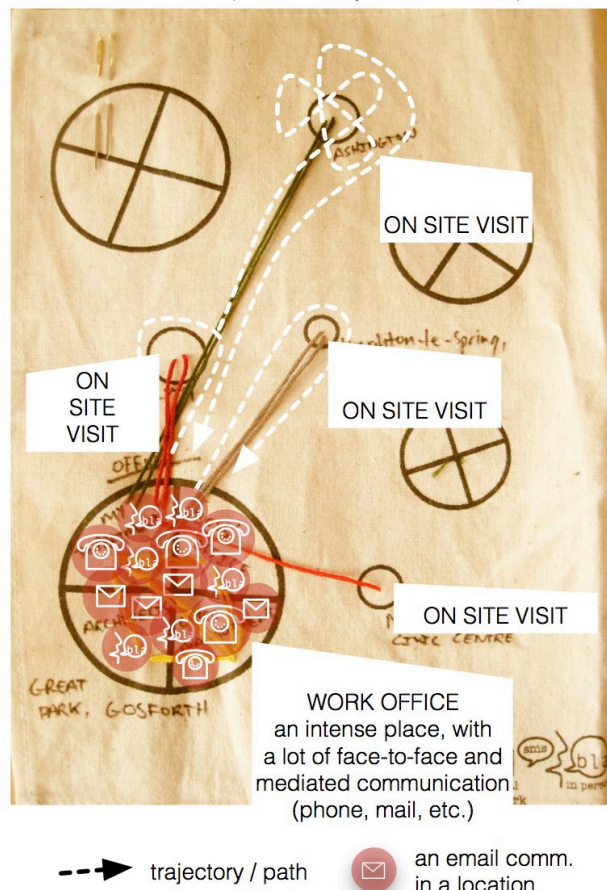


Figure 5.27. MWC5's curated Probe introducing the instance of mobile interaction trajectories.

5.3.4 Interpretation of completed Hankie Probes

The next sub-sections discuss the completed Probes' characteristics. I will emphasise the type of feedback that the Probes elicited and discuss the responses' scope.

The Probes interpreted as mobile interaction trajectories: The following two examples are taken from the two main probing experiments. I will use these examples to discuss how the Probes feature mobile interaction trajectories. These examples are an extended textual description in addition to what is illustrated in the previous section.

Example One - mobilising relationships: Couple MRS3 is in their late twenties. They don't share a flat, but live in the same town and work at the same university. In the interview they indicated not having seen each other often during the Probe recording period. They describe this as typical. The two don't see each other in person on a daily basis, but spend more time together over the weekend. They mainly use phone calls and text messages to stay in touch during the week. Their mediated communication in that period appears to be imbalanced. He is more active, she is more passive. During the day he instigates most of the communication, while she only responds with short messages. She reports to be busy during the day due to her research work. She only becomes more active in the evenings. In addition, she roams in between her flat, her office and the lab, which isn't co-located at university and requires her to travel outside town. His trajectory instead is less tightly organised. He mostly roams between home and work and his work is more flexibly organised and less stressful. Their communication also has a certain chronology. He gets in touch with her in the morning and before going to bed. He also tries to contact her during the day, for example when he takes breaks from work. Knowing her schedule he times messages around the time she finishes work. She instead does not instigate communications during the day. She is too busy. Only in the evening does she become more proactive.

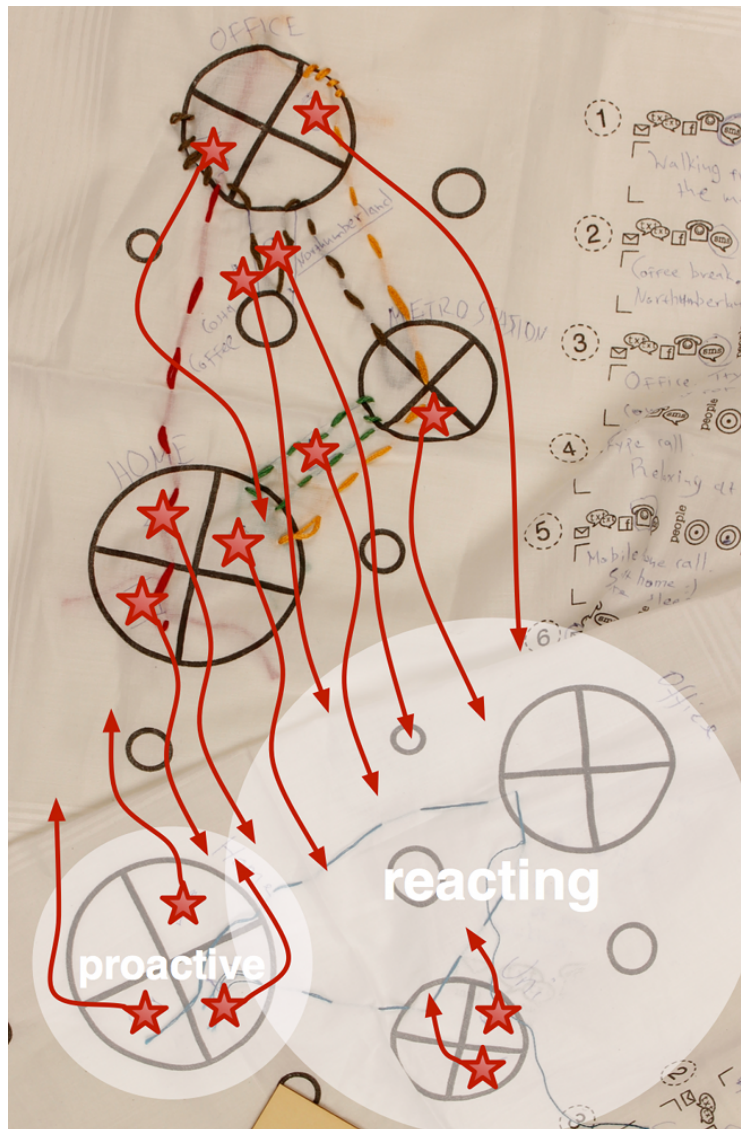


Figure 5.28: MRS3's space-time diaries: Each picture shows two space-time diaries side by side creating the couple's map of daily trajectories. His space-time diary on top, her space-time diary at the bottom. The stars indicate text messages to the other person. **The annotation indicates the imbalance in their communication.** It further indicates that she becomes more active in contacting him in the evenings.

They both experience this situation differently. She feels stressed about her work situation and describes herself as a functional person. Only in the evenings but even more so over the weekends does she feel more relaxed about work and her situation in general. Her accounts indicate that she experiences his messages as an additional thing she has to deal with. Their mediated communication leaves a negative experience for him too, which he does not express up front, but which their accounts let shine through⁵⁰.

⁵⁰ SHE: "There may be days though, that we don't see each other and then that would be probably where you "have to" write a message. INTERVIEWER: You have to? SHE: Yeah, you know, he would be disappointed. HE: Me disappointed? No! Well, it depends."

Interpretation as mobile interaction trajectories: This instance of mobile interaction trajectories shows **how communication is influenced and structured according to people's individual trajectories**. It emphasises **different state of connectedness during the day** and an individual **communication chronology**. Their relationship is delocalised and partly lived through communication technologies. Their contact with each other is subject to their daily conduct and to the 'things' they do. The chronology of their mediated communication is embedded into *her* tight schedule, which seems to be the synchronising pulse for their mediated interaction, leading to different periods of connectedness and disconnectedness over time. He tends to send messages in the morning or in the evening, when he expects her to be finished with work and therefore more responsive to his text messages. The messages they send are their *moments of connectedness*. Both however experience these moments differently. She experiences his text messages as an additional burden. In the context of her work, moving from her home to the office, to the lab and back it is an additional thing she has to manage. He is disappointed having to instigate communication most of the time, and the feedback he receives is not what he wants. The example shows that both their schedules and their contextual situations during their daily trajectories influence the practice and experience of being connected. Their daily trajectories are intertwined by virtual means and by the awareness of their schedule. For example, he indicates to contact her around 5 to 7 o'clock. This is when she leaves work and when she is more likely to be in the mood for communication. This affects the chronology, locality and emotional experience of their mediated communication.

Example Two - Involving work communication: MWC1 is a journalist and works at the broadcasting studio of a radio station. She also works as a historian at a museum. She is married and mother of two children in their teenage years. In addition, MWC1 is in the process of writing her PhD dissertation. She has three important places for her work: Her private office, which is located next to her flat, but with a separate entrance. She works at the broadcasting studio and at the museum. She roams between these places, but without any pre-set schedule, as she reports. The time she spends at these places is subject to museum programmes, exhibitions and radios shows she is involved in. She mainly uses phone calls and email to get and stay in touch with her interviewees for her radio shows, but also to organise programme details with her superiors at the broadcasting studio. She mainly uses emails to manage her schedules with the museum.

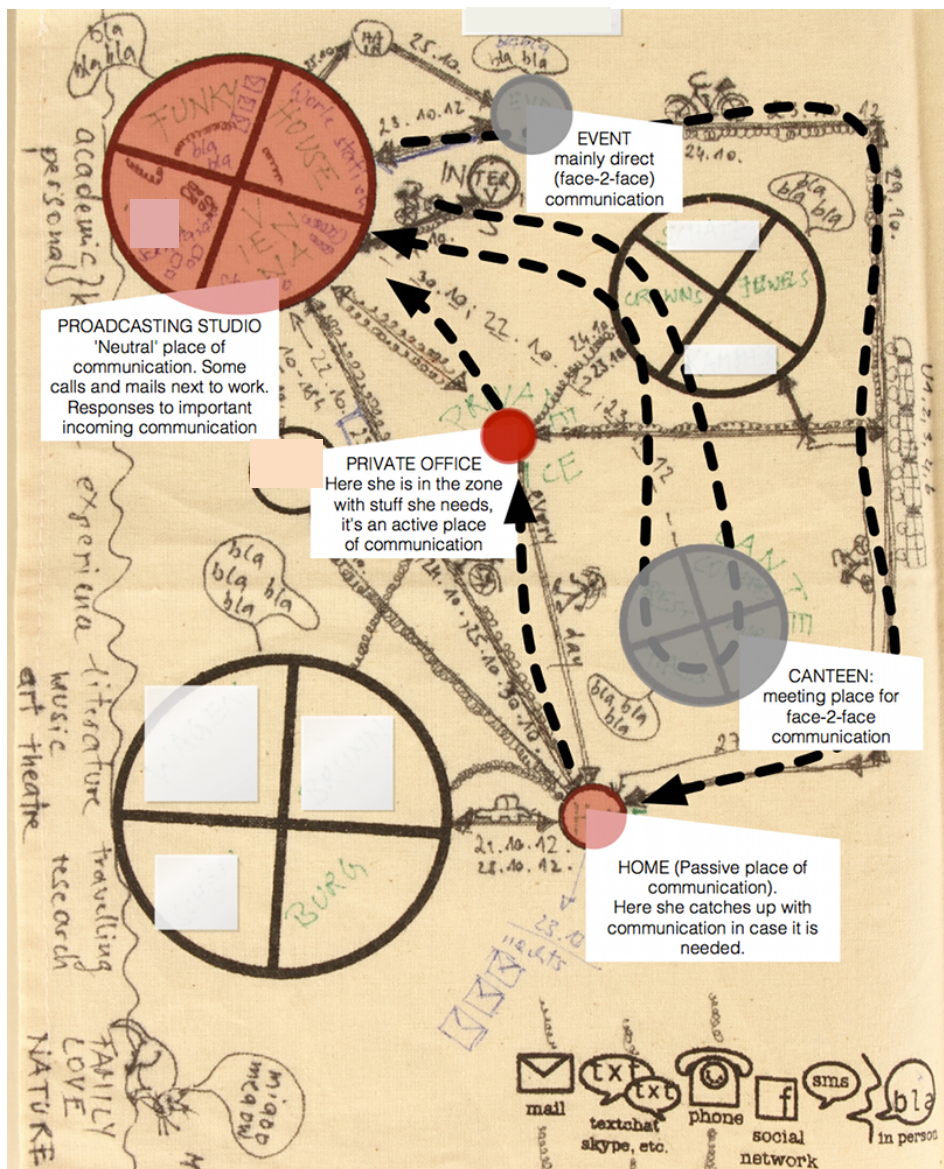


Figure 5.29: MWC1's space-time diary. Annotated by the thesis researcher to highlight her places and the central role of her private office for mediated communication. **The annotation shows one exemplary trajectory, including two places with intensive media use (red) and two places with little opportunities for mediated communication (grey).** The example highlights different periods of connectedness as part of one trajectory.

The completed Probe and the interview showed that her private office is highly important for her work in general, but also in terms of mediated communication. The interview revealed this place as offering favourable conditions for mediated communication. Her private office is a place to retreat, which allows her to do research in preparation for her radio shows and to set-up and conduct interviews for her radio session and PhD research. This is the place where she is able to manage all the mediated communication that she maintains as part of her work. While her daily trajectory leads her to various places, her private office is the place

that allows her to organise her mediated communication. The interview revealed that her private office is the place where she finds the infrastructure to do her work and to communicate properly, with access to her calendar, internet, a dictionary, communication history, etc. During working days, e.g. when she produces radio shows, she catches up with some important communication streams immediately. However, she also keeps less time-relevant communications for later when she is back to the office or her home.

Interpretation as mobile interaction trajectories: This instance emphasises a **structured communication routine, which is organised around one particular place**. The chronology and contextual characteristics of her trajectory structure her mediated communication. The completed space-time diary shows that the respondent is roaming across several places. Although her (mediated) work communication spreads over a range of places her private office is the centre. She also hinted at going back to her private office at the end of a day to catch up on unanswered emails. This reveals a certain chronology of communication and a mobile communication routine. In order to be virtually mobile she needs to be physically immobile and shield herself off. Her private office becomes a hub of intensive mediated communication. During the day her work activities and the locative contexts are too demanding and leave little space for dealing with mobile connections to distant others next to work tasks. She has to make space for these communications at the end of the day. This example shows that the attention on mediated communication changes over time, leading to different periods of connectedness. At her private office the attention and intensity of mobile communication increases compared to other places of her trajectory.

5.3.4 The completed Probes' content

The completed Probes are a narrow compendium of respondent's practices and experiences. The recording period was rather short and the Probes only cover a small (to tiny) excerpt of their lives. They reveal a small part of the Probe respondent's relationship (first experiment) and their work communication (second experiment). The completed Probes nevertheless show certain characteristics across the thematic clusters identified, which are clearly influenced by the middle range theory of mobile interaction trajectories.

Despite the overall similarities, each completed Probe is unique and expresses a different level of detail and individual practices and experiences. Some

respondents made broad use of the space-time diary, with less emphasis on recording the contextual aspects of each moment of connectedness. Others returned an intricate and well-ordered overview of purpose and context of their device use, but with a less elaborate space-time diary.

Everyday trajectories: The Probe's central element is the space-time diary. Hence, common features amongst the completed Probes were movement patterns expressed in everyday trajectories. The majority of returned Probes depicted rather *structured movement patterns*, like home-work-home. To get an insight into such patterns, the recording time in this study seemed long enough. Only a minority of completed Probes presented distinct patterns and included unexpected places and trajectories. Respondent MWC4's trajectory is one of those. He indicated working at his house at the countryside. Also Couple MRS2's response indicated multiple places and patterns that were out of the norm (at least compared to the other completed Probes). Their space-time diary showed a rather random-looking map that included places like university (where they study), cafes (where they meet), a pub (where she works) and a school (where he works). For such cases, the recording time seemed to be too short to understand a clear order or a pattern-like style in their behaviour.

Intermediaries, locative and mediated contexts: Interview accounts led to more detailed descriptions of places and locative contexts of everyday life too, which talked about the people who respondents meet, the electronic devices and other objects they carry with them. However, the completed Probes did not contain detailed information about respondents' devices. There were little insights highlighting the design and characteristics of respondents' intermediaries.

The Probe interview led to descriptions of particular places that people went to as part of their trajectory. In most cases these were descriptions of places and contexts of everyday life in which respondents reported using mobile communication devices. These accounts partly also included the physical characteristics of a place, e.g. that a path is surrounded by trees and nice to walk on, or for example that a visit to a construction site is nice in contrast to a busy office. Respondents also accounted for places that are exempt from mediated communication. This introduced a balanced view between contexts of intensive mediated communication opposed to other ones that are free from device use. In some places respondents indicated not finding any time, space, nor the right mood

to connect to others virtually, due to work activities or the social context. Respondent MWC1's account about her private office, which offers her optimal conditions to get in contact with her interviewees, is a prominent example of a place that is characterised with intense mediated communication. In contrast, she described her work at the broadcasting studio as too tense to catch up with any mail, apart from the most important ones.

Similar to intermediaries, the completed Probes did not reveal extensive insights about respondents' *mediated contexts*, e.g. the Probes did not include general accounts about people and places respondents are connected to. Rather, the completed Probes expressed respondents' awareness about and characteristics of remote people, places and contexts via accounts about moments of connectedness indirectly.

Moments (and periods) of connectedness: Discussing respondents' moment of connectedness revealed mediated communication practices as part of everyday trajectories. For example, the interview with couple MRS1's revealed their habit of getting in touch on their way home from work, which can be described as a *mobile communication routine*. They do so to arrange evening activities, like food or leisure activities. It is a way for them to understand what the evening will bring. Such mobile communication routines were only partly visible on the space-time diary. Rather they emerged in the interviews with respondents, who explained how, when and where they use their mobile communication devices. These accounts revealed the purpose and experience of these reappearing communications too. To better communicate these recurring structures of mediated communication, chronologies of communication and changing states of connectedness in design workshops I annotated the Probe's space-time diaries to express these virtual communication structures in the context of respondent's trajectories (See Figures 5.28 and 5.29 showing annotated space-time diaries).

These changing states of connectedness, chronologies of mediated communication and mobile communication routines reflect mobile interaction trajectories' core ideas. The interview analysis showed that each completed Probe revealed 4 to 7 thematic topics (see section 5.3.1 *Completed and curated Probes*). Some of these topics refer to one-off communication or one-off contextual situations. However, most of the Probes revealed a theme that can be interpreted as a mobile communication routine, a chronology of communication or a situation

describing changing states of connectedness. The curated Probe's instances of mobile interaction trajectories highlighted these aspects for design workshops. In most of the completed Probes, these aspects were so prominent that I named them. In the first experiments, I called them *mobile experience ensembles*. The name hints at the couple's orchestrated and interlinked trajectories. In the second experiment, I called them *mobile communication strategies*, which express respondents' individual strategies for managing their virtual work communication. Each curated Probe was presented with this particular theme to the design teams. For example, the experience ensemble "I want to be part of it" introduces couple MRS4's recurring communication routine. This overarching title hints at couple's behaviour when communicating with each other. The interview had revealed that she was asking her boyfriend for status updates rather regularly while sitting at work (minimum every 2 hours, starting from 10 am in the morning). These status updates referred to their mutual project, namely repairing a van.

- *Mediated communication practices:* The interviews revealed the actual practices of staying in touch. This showed people's individual practices of *moments and periods of connectedness* that make the overall communication routines and chronologies come to life. The interviews revealed people's individual device use. This introduced examples of how respondents organise email inboxes, how they carry their mobile devices with them or what they do when they receive a call, e.g. walking circles during phone calls. For example, MRS3a's explained that she is never sure where she has her phone. This prevents her from instigating phone calls. MRS1a's told that at night she places her mobile phone on a shelf next to the entrance door. Some examples indicated how respondents make space for mediated communication in response to locative contextual situations. MRS5a explained that she escaped to the toilets during a girls' night out to phone her boyfriend. These examples partly explain respondents' practices with particular device features too. MWC1's explained that she uses an email client. Incoming emails generate a small pop-up on her screen showing the email's first line. This allows her to decide which emails to take care of right away and which ones to keep for later. Another example is MWC5's Probe, which revealed that he has no mobile work phone. He needs to catch up with most of work related email business on a rather old and fixed desktop-computer in his office. This explained his approach to email management and partly also his physical trajectory.

- *Experience accounts:* The interview accounts also revealed how respondents experience their moments/periods of connectedness. They depicted a more emotional and affective picture of the overall communication routines, chronologies and different states of connectedness. It also made some communication practices appear more interesting for the purpose of design. For example, the interview with MWC5 showed that he experiences his office environment as quite tense and as a very busy place. He regularly visits construction sites, which he experiences as relieving and relaxing. MRS3's account explained how she feels about her boyfriend contacting her during the day. She experienced the need to respond in between and during work as a burden. MRS4a's experienced her messages to her boyfriend as a way to keep in touch with their mutual project (the van repair). For him instead it was an additional thing he had to catch up with, next to his work and fixing the van.

Respondents' personalities and the type of work or relationship: The completed Probes partly accounted for the actual relationships (first probing experiment) or the work practice (second probing experiment), e.g. the type of work they are doing, or accounts describing their relationship. Similar was the case concerning respondents' personalities. Particular descriptions of personalities, the relationship or jobs were not a prominent aspect of the debriefing interviews. In some cases, more detailed descriptions were however necessary to explain the particular use of communicative channels. Respondent MWC3, for example, needed to explain his work as a service engineer in order to clarify when he was communicating with whom and why. In other cases, such aspects shone through the described behaviours and experiences indirectly. For instance, MRS3's account about their mediated communication during normal workweeks left the impression of a rather unbalanced relationship and a different level of commitment from each partner. The level of implicitness (or explicitness) in respondents' accounts differed from Probe to Probe response. There are examples of each extreme. MWC1, for example, rather directly pointed at her work-life being an integral corner stone about her personality by drawing her *pillars of life* on the space-time diary.

5.3.5. Between bland and surprising

Some completed Probes can be characterised as being rather bland, while some are rather surprising. The Probe design asked people to describe their practices and experiences, but less so to talk about their dreams and wishes for the future – as, for instance, Sanders describes probing and similar approaches (Sanders, 2010). This focus on the *current* resulted in completed Probes that appear as pragmatically described situations of everyday life. Those completed Probes don't show up as situations that are out of the ordinary. Getting in touch after work, as couple MRS1 did, does not sound alien to most people living in relationships. Neither is MWC1's practice of attending to important email immediately, but pushing the unimportant ones aside.

Some completed Probes hinted at single events, which sounded more out of the ordinary. For example, MRS5a's trip to a fashion show during a girls' weekend can be classified as such a single event. Couple MRS4's account about their van repair was another example of a one-off case. These are interesting because they describe situations with rather unique contextual characteristics. Since the respondents in both main probing experiments mostly recorded their everyday life, such out of the ordinary situations were the exception rather than the rule. The completed Probes that reported such single events seemed more interesting and surprising at first glance. They seemed to offer more obvious starting points, unique situations and therefore a more interesting ground to look for opportunities for generative design.

The mundane-sounding Probe responses became more valuable once respondents discussed their motivations for particular practices. Respondent MWC2's account of email management does not result in something very surprising. She manages her project using different folders in her email inbox. This is a common thing for people to do. The response became more interesting when the respondent started talking about her *motivation* to do so: she aims to keep projects separated time-wise (doing one thing after the other); at least as far as daily project work allows her to do so. This wish articulated in reference to the described practice created a more interesting situation for design. It makes the viewer wonder how multiple mediated connections can be managed with future technologies. Similarly, couple MRS1's description of getting-in-touch after work in a routinised way is not surprising at first sight. It is something almost expected and understandable to take place as part of a relationship. The Probe response again

becomes more valuable when their motivation was revealed. They try to find out 'what the evening may bring?' at a time when they still have multiple options.

The quality of the completed Hankie Probes is therefore to be found in the new and surprising but also in the mundane everyday situations that become interesting when being enhanced with personal motivations and experiences. However, both types of feedback can be a valuable starting point for design. This corresponds with Coughlan and Sklar (2003), who highlight the value of individual accounts and motivations explaining general behaviours as essential input for design.

5.4 Summary and conclusion

This chapter presented a design resource portfolio that introduced completed and curated Probes, manifesting instances of mobile interaction trajectories, created from respondents' feedback during the two main probing experiments of this thesis research. The instances, which introduce mobile relationships and mobile work strategies, are presented through the theoretical lens of mobile interaction trajectories, and are interpreted as materialised real-world examples of this middle range theory. The Hankie Probe's design is influenced by the articulated theory and by the practical design settings of this thesis research – as well as by my subjective preferences for designing the Probe.

The design resource portfolio has presented the raw, completed and curated Probes. It has described the nature of the raw Probes and introduced each completed and curated Probe of the two probing experiments. This portfolio aimed to describe the Probe's background, design and completion in a way that other design researchers can adopt (parts) of the Probe for their particular design settings and projects. Nevertheless, the following Chapters 6, 7 and 8 will extend this discourse about the values that have been discussed so far with more detail based on qualitative evidence.

The Probes led to a selection of people's routines of daily conduct, which explain some of their behaviours and experiences of staying in touch with distant others. These were a prominent feature in completed Probes from different respondents. Most of the completed Probes hint at one or more routines that the respondents follow up in everyday life. The core aspects describing these features are people's

trajectories, which give a core structure to the Probe responses. They indicate how Probe respondents move on a daily basis and hint at the chronology of device use that is embedded in these daily structures. As part of these everyday movement structures, the completed and curated Probes feature particular places of communication and respondents' contexts of periods/moments of connectedness. The curation of each Probe made use of trajectories and mobile communication routines, although some of them appear rather mundane and expectable. The curated Probes' nevertheless hint at the respondents' actual practices and experiences that make these routines, chronologies and changing states of connectedness more inspiringly individual.

To summarise, the completed and curated Probes introduce insights about users and contexts that offer **two perspectives that** for interpretation: a *practical* perspective, which describes people's trajectories, intermediaries, locative and mediated contexts as well as their practices and activities, and an *experiential* perspective, which describes an affective and emotional level related to the practical level. In addition, the completed Probes captured a perspective hinting at respondents' *personalities* as well as at insights relating to their type of work and relationship on a more general level. These levels can be separated conceptually, but should not be treated as separate. These perspectives are intrinsically intertwined.

The presented user and context focused design resources form a *design resource portfolio*. A design theory cannot objectively be translated into practical resources, nor can fixed designed resources fit every unique design situation. Design resources can only be objectified and generalised to a certain degree. This requires the presentation of design resources to embrace a format that avoids being wholly rationalised. A design researcher's portfolio should also foreground the researcher's subjective stance on theory and design processes, but still cover the design settings for which the resource was designed. The portfolio presented in this chapter aimed to do so by discussing the Probes' scope and contents, but also by presenting curated versions of each completed Probe. The portfolio's aim is to provide sufficient detail for other researchers to decide whether they can and should adopt the resource for their own approaches. A portfolio is one way of presenting new design resources without the pretence of general validity. The presentation of the Hankie Probe in this portfolio is an attempt to use such a presentation format. In doing so, this design resource portfolio discusses the

motivations, the practical and theoretical background of the resource, but without making claims for a general validity across different design settings and application domains. What is demonstrated here is a methodological competence (compare Keinonen, 2009). It is a grounded statement about a potentially fruitful way of working.

Appendix 5.3 provides additional reflections on respondents' use of the fabric-based Probe format for insights collection. The next chapter (Chapter 6) will discuss how this design resource portfolio performed in design workshops, pointing out its advantages and disadvantages for particular design settings. This further explains the resources' value for broader use.

Chapter 6: Mobile interaction trajectories in generative design workshops

This chapter discusses the value of the middle range theory of mobile interaction trajectories in design workshops. It is in line with the primary research strand: *The value of mobile interaction trajectories for generative design processes*. The analysis aimed to identify the theory's influence on the design process and design outcomes and drew from two types of analyses.

First, it investigated the processes that design teams went through, which were recorded over the course of the two main probing experiments. Second, the analysis looked at the design outcomes to identify the proposed design concepts' attributes, and to identify similarities between these concepts. This allowed identifying which types of design concepts the work with mobile interaction trajectories leads to. A list of all resulting design concept is presented at the end of this document.

For this analysis, the curated Hankie Probes are considered as instances of mobile interaction trajectories – as described in Chapter 5. The instances are structured and outlined based on this middle range theory. It is therefore plausible to consider the theory as *directing* and *invigorating* (Cockton, 2013) the design processes and design concepts⁵¹.

I will first describe the process of data analysis, present the results of both types of analysis (analysis of design processes and resulting concepts), and then provide a more detailed discussion of these findings.

6.1. Data analysis

The chapter draws from two types of analysis to help understand the theory's influence on the design processes. **First**, it draws from the **analysis of the design**

⁵¹ The curated Probes are not a neutral objective point from which to start a generative design process, but offer theoretically and thematically pre-selected insights for design teams. The curated Probes are channeled views into respondents' lives. Instances of mobile interaction trajectories are sparse but nevertheless offer multiple perspectives to inform and inspire a generative design process. Although they are channeled views, they still allow a degree of interpretative freedom.

teams' design processes with the presented instances of mobile interaction trajectories. This showed which theoretical aspects of mobile interaction trajectories inspired and informed the design teams' work. **Secondly**, the analysis **looked at the proposed design concepts**. This revealed which design concepts the work with instances of mobile interaction trajectories stimulated.

6.1.1 Analysis of design teams' processes

This analysis is based on the principles of *protocol analysis*, as it is used in design studies, e.g. in Cross et al (1996). The principles of process analysis were described in Chapter 4 Methodology. I adapted *protocol analysis* for the aim of this research – which will be described in the following. Figure 6.2 shows an example of a coded workshop transcript, together with details explaining the analysis process. Furthermore, I followed Lazar et al.'s (2010) and Rogers et al.'s (2011) process of qualitative data analysis (transcription, identification of critical incidents, coding into content categories).

6.1.1.1 Data sources

I considered two main data sources for this analysis (See Figure 6.1): The protocols of workshops A to D (design workshops of probing experiment one) and the ones of workshops E to H (design workshops of probing experiment two). The protocols of workshops E to H cover the entire design teams' discussions, from first exposure to the Probe until the articulated design concept, showing their design process from beginning to end. The protocols of workshops A to D only cover the post-design reflection, because designers worked on their own. Designers were not asked to protocol their design process. Thus, these workshops' protocols only cover the designers' post-design reflection. When they are available, I also consider sketches and notes that designers made in workshop A to H for this analysis. Lastly, I also consider my own experience in working with the Probes and observing the design teams' work as an additional supportive, if minor, source of evidence.

The analysis drew from design theories for early design stages. According to Löwgren and Stolterman (2004) designers introduce a *vision* to organise the design context – as described in Chapter 2. Over the course of their process they turn this vision into a *design concept*. This will be elaborated in the next sections.

6.1.1.2 Insights about users and contexts, design vision and design concepts

The following definitions are based on Löwgren and Stolterman's (2004) discussion - as discussed in *Chapter 2 Contextual literature review*. In this analysis, the Probes are understood as insights about users and context, the framing and structuring of which are based on the theory of mobile interaction trajectories. These are focal excerpts of users lives (see Chapter 5). The design teams explored these insights during the design workshops.

A design vision is a designer's idea about how to respond to insights about users and contexts. It is an understanding or statement of *what should be done*. A design vision does not necessarily point to a concrete design concept, but is a rough idea of the direction in which the design solution should go. Over the course of a project, a design vision can evolve and change aligned with the development of a design concept. An articulated design vision does not necessarily lead to a design concept.

A design concept is an idea for a new product or service, represented by a design sketch, or a textual or verbally articulated description. It is understood as the (interim) outcome of a generative design process. The analysis considers different states of a design concept at different points during a design process. This can be a statement, an utterance or a sketch, which indicates and defines the appearance, function or purpose of a design concept. A design concept is an objectified version of a design vision that indicates how a design vision can materialise.

6.1.1.3 Process of the analysis

The first type of analysis aimed to understand how the instances of mobile interaction trajectories supported designers in articulating *design visions* and (ideas for) *design concepts* throughout their design process. Articulated design visions and design concepts were used to identify critical incidents for further analysis. Two level of analysis were applied:

1st Level: The core entities for this analysis are the protocols of the four design sessions E to H (see Figure 6.1). First, I identified a number of critical incidents in the transcripts (see Figure 6.2). A critical incident was identified when a designer

mentioned a *design vision* or articulated a *design concept*. I then thematically analysed the transcripts in order to realise a categorisation of aspects of mobile interaction trajectories that appeared to influence the design work. This thematic pre-analysis revealed which aspects of mobile interaction trajectories were used to inform the design process. In other words, the analysis tried to understand if, and how, designers benefit from the curated Probes indicating people's everyday *trajectories*, places, contextual characteristics, their practices and experiences of mediated communication. The emerging themes were organised in categories.

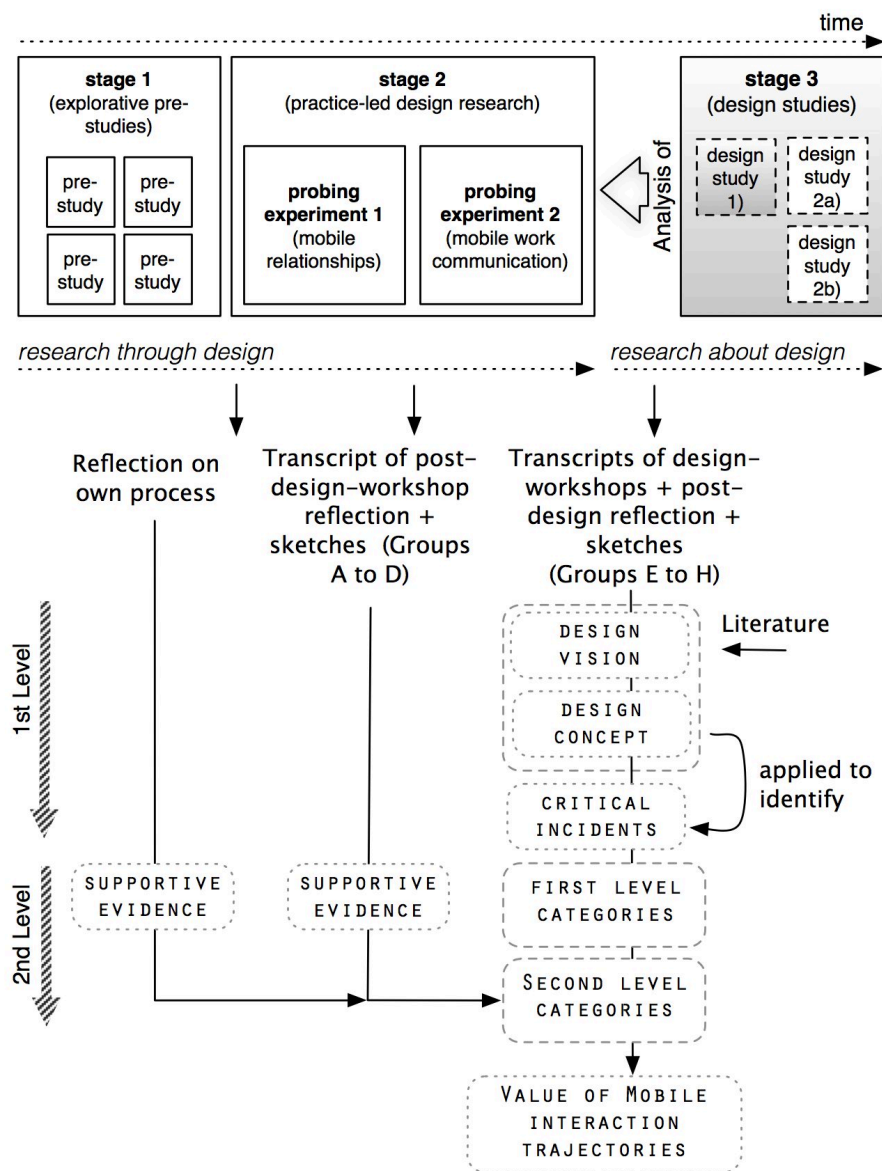


Figure 6.1: Data sources from the two probing experiments for the analysis of the value of mobile interaction trajectories in design workshops.

2nd Level: Then, each critical incident was interlinked with the categories and sub-categories that had emerged during the first level analysis. This revealed which of

those categories played a role for the articulation of *particular* design visions and design concepts. This 2nd level analysis however, also looked at the visions' and concepts' content. In turn, this allowed interlinking the proposed design directions with specific aspects of mobile interaction trajectories. Hence, the analysis tended to indicate which *type of visions/concepts* a particular aspect of mobile interaction trajectories stimulates.

The 1st and 2nd level analysis made direct use of the workshop transcripts (Figure 6.2), which indicated a number of critical incidents, as well as those aspects of mobile interaction trajectories that contributed to each of these articulated visions and design concepts, e.g. a designer arguing for a design concept with reference to a characteristic of a locative context, or a designer uttering a design vision in relation to a respondent's trajectory⁵². This showed how mobile interaction trajectories' aspects informed and inspired the design processes. Further, it allowed counting, not only the number of articulated design visions/concepts, but also the frequency in which each aspect of mobile interaction trajectories contributed to visions and design concepts.

In a secondary and supportive process, I considered the post-design reflections of design workshops A to D. I went through the post design reflections and the designers' design sketches. Then, I applied the identified categories to that data source. This revealed supportive evidence that reinforced the main claims. I also reviewed my notes about the design process as a minor input for this analysis. The full protocols showing this analysis can be found in the Appendix 6.1, 6.2 and 6.2 of this document.

⁵² The following two examples illustrate the classification work. Example 1: In workshop H designer H1 stated the following: *"She says the train is really important, and then she says that the university office is a open space and that she likes having people around to ask... 'what do you think?', 'how does that work?'"* This was classified as 'contextual' insight, as the designer makes use of respondent's reflections about a particular place. Example 2: In Workshop E, designer E3 stated: *"Its quite interesting... If he has the opportunity to get to the field [note MWC5's on-site trips], then he enjoys it. It's a break from work. It is something we can design for..."*. This was classified as insights about 'trajectories' that informed the design work, as the designer reflected on the respondent's physical mobility.

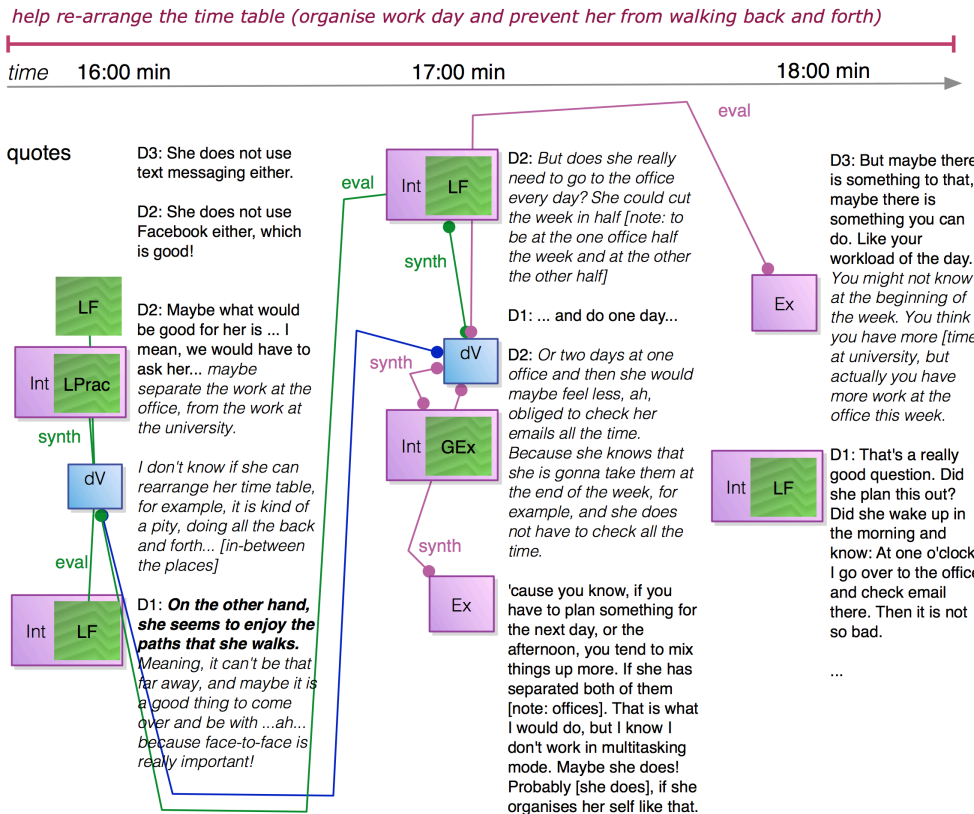


Figure 6.2: Protocols: critical incidents (in blue) interlinked with themes coming from mobile interaction trajectories (in green). Purple labels mark designer's input, which will be discussed in Chapter 7.

6.1.2 Analysis of design concepts

As a result of both main probing experiments, the design teams proposed 37 design concepts in total. For this analysis, I classified each concept's basic attributes in relation to the middle range theory of mobile interaction trajectories. An *attribute* describes an essential characteristic of a design concept. The first level analysis examined the design concepts' relationship with the middle range theory's following aspects:

- *Trajectories and locative contexts*: The analysis reviewed if and how design concepts reflect, incorporate and respond to everyday trajectories and insights about locative contexts.
- *Mediated contexts and moments/periods of connectedness*: The analysis reviewed if and how design concepts reflect, incorporate and respond to insights about mediated contexts and moments of connectedness.
- *Intermediaries*: The analysis reviewed which type of communication **devices and services** the design concepts proposed, e.g. physical device designs,

such as wearable devices, integrated in stationary objects, services running on smart phones, (etc.). The analysis also reviewed which communication **media** the design concepts proposed, such as communication via video, voice, sound, tactile interaction (etc.).

I classified each design concept if it had an obvious relationship with one of these aspects. For example, if a design concept obviously related to a contextual artefact that was described in the curated Probe I classified it as *contextual adaptation (to the locative context)*, or if the design concept obviously sought to change the described chronology of mediated communication I classified it as *changing chronology of communication*. For example, one designer proposed an interactive radio, which changes volume depending on another person's mood. This may help decide when to best contact this other person. I categorised this concept with the attributes *contextually adapted*, because it integrates in a local radio device. I also categorised this concept with the attribute *create awareness about other person's trajectory*, because the concept aims to provide awareness about a distant person's mood over time.

Each design concept may have one or more attributes. If necessary I referred back to designers' comments and design rationales for classifying each design concept. The 1st level analysis led to six overarching attribute categories. The second level analysis refined and finalised the attribute categories. At this 2nd level analysis, a seventh attribute-category was identified, namely *Interlink trajectories with communication and awareness services*. In this way, the analysis of the 37 design concepts led to seven overarching attribute categories, which are shown in Table 6.1⁵³.

⁵³ Appendix 6.1 and 6.2 document the design concepts and their classification.

6.2 Results Overview

This section summarises the main results, which are then presented in more detail in Section 6.3.

6.2.1 Mobile interaction trajectories' aspects that informed the design teams' processes

Five categories emerged from the analysis of the design team's processes, with one of these having two sub-categories. A count of the instances of these thematic categories is displayed in Figures 6.3 and 6.4. These two figures give a sense of how prominently these aspects contributed to the articulation of *design visions* and *design concepts*. Obviously, the design teams articulated a higher number of design visions but proposed fewer design concepts. This is the case because not every design vision was developed further into a design concept.

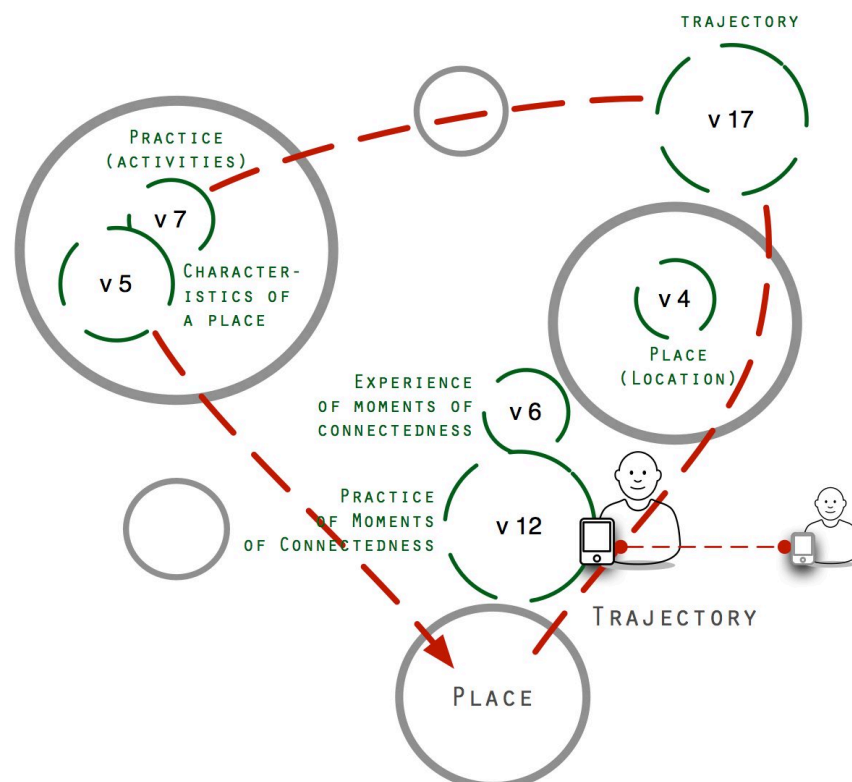


Figure 6.3: Number of direct influences of the aspects of mobile interaction trajectories for the articulation of design visions. For example, “v 12” stands for 12 articulated design visions that showed to be inspired and informed by this aspect.

The analysis showed that insights about *intermediaries* did not influence the design processes, as the instances of mobile interaction trajectories did not communicate such insights (as discussed in Chapter 5). Insights about *mediated*

contexts influenced the design processes, although in close conjunction with practices and experiences of moments of connectedness. Consequently, there is no separate category describing mediated contexts' influence. Rather, mediated contexts' influence is covered by categories 4 and 5, which are described below.

1) *Trajectories*: The chronologies and places of respondents' everyday trajectories informed the design teams' process to a considerable extent. Inspired by these insights, designers discussed where (places) and when (times) they should intervene with respondents' trajectories. A prominent *vision* was to change or enhance the described trajectory through design, e.g. making people change their daily trajectories through new communication technologies.

2) *Locations*: A trajectory describes a range of locations that people go to. These insights informed designers' process too, but were only minor sources informing design visions and design concepts. Nevertheless, it informed design teams imagining software applications, e.g. a location based services, to react and behave differently across different locations. This category is not representing the *experience of places*, e.g. perceiving a place as calm or optimal to do some work in. This aspect is covered by the next category: *locative context*.

3) *Locative context*: This category holds two sub-categories, which both refer to mobile interaction trajectories' aspects of locative contexts.

- 3a) *Characteristics of a place*: This sub-category describes the experience of a place as well as contextual characteristics, like products or artefacts that are used in this place. First, respondents' **contextual experiences** (how do people experience a place) formed a design reference, which designers aimed to enhance or replicate in different locations. Secondly, **contextual artefacts** informed the gestalt (the actual look-and-feel) of a design concept. Examples are products, devices and accessories that Probe respondents reported using. For instance, a designer aimed to integrate a technology in a piece of jewellery that the respondent had indicated wearing.
- 3b) *Activities and practices*: The sub-category refers to designer's statements **referring to respondents' activities/practices** in relation to a place, e.g. the specifics of work tasks or the couples' activities in a place. Such insights triggered ideas of how to improve the work practice and the couples' activities.

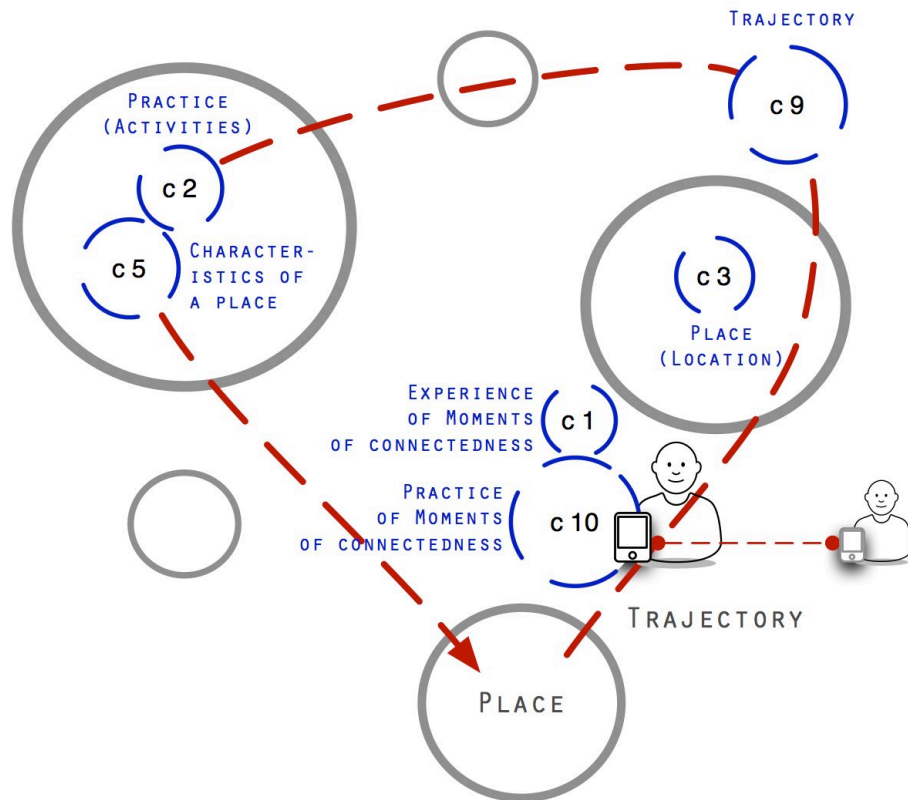


Figure 6.4: Number of direct influences of the aspects of mobile interaction trajectories for the articulation of design concepts. For example, “c 10” stands for 12 articulated design concepts that showed to be inspired and informed by this aspect.

4) *Practice of moments of connectedness*: The Probes described the way respondents practice and experience their mediated communication. These insights inspired visions and design concepts that disrupt the described chronology of mediated communication. Thus, this category covers designers’ aim to change how, when and where mediated communication takes place.

5) *Experience of moments of connectedness*: Designers also informed their design work by referring to respondents’ experiences, e.g. emotional accounts of moments of connectedness. These experiences mainly inspired visions; hence, they triggered thoughts about *what should be done*. However, although it was a focus for some design work, this category’s exact influence on design concepts was less clearly traceable, e.g. insights about experiences of moments of connectedness did not show to inspire a particular type of design concepts.

As well as indicating the influence of mobile interaction trajectories, the analysis revealed other influences on the design process too, which are discussed in

Chapter 7. This broader view of the design processes will show the role of the designers' experience, the relevance of the space-time diary for exploring the curated Probes, and also the impact of the Probe respondents' personality. In this chapter however, the analysis' main focus lies on the value of mobile interaction trajectories in design workshops.

6.2.2 Resulting design concepts

The research included twelve design workshops (four in experiment one, eight in experiment two, where 4 design teams conducted 2 sessions each workshop) that led to 37 design concepts. The analysis of design concepts resulted in seven attribute categories.

Table 6.1 indicates the design concept's attributes in response to each instance of mobile interaction trajectories. In workshop A to D each designer worked individually and proposed between one and four concepts in response to the Probe that s/he worked with. This resulted in a higher number of proposed concepts. In workshops E to H designers instead worked as design teams and were asked to present one outcome as a group. Hence, these design workshops resulted in two final design concepts (each design team conducted two sessions looking at one particular instance of mobile interaction trajectories).

Table 6.1 also shows the categories of concept attributes and the frequency in which they emerged. According to this analysis, the work with mobile interaction trajectories leads to design concepts that propose new communication media to connect people with each other. The concepts are contextually adapted and aim to change the chronology and locality of mobile connectedness. For example, designers proposed services that allow better approaches of asynchronous communication, e.g. by providing communication summaries at the end of the day. Other proposals aimed to make respondents' check their phones less often or only in particular places. The category *new communication media* describes design concepts' attributes aiming to connect people via new media, but not necessarily altering the time or place of communication. For example, one designer proposed to replace a couple's text messages with an adapted video service. The primary aim was not to change the time or place of their mediated communication, but the experience of being connected. *Contextually adapted devices and services* aim to fit communication media to changing contextual situations. In this respect,

designers considered two approaches: they designed body-mounted devices to integrate communication more seamlessly into everyday activities, but also imagined devices that would integrate in the user's periphery.

	MRS1	MRS2	MRS3	MRS4	MRS5	MWC1	MWC2	MWC3	MWC4	MWC5	No. attributes
Nr. Of concepts: 37	7	1	8	7	6	2	2	1	1	2	
Change Chronology of communication (<i>time/place; synchrony/asynchrony of communication</i>)	2	1	1		2	1	1			1	8
Contextual adaptation (<i>through new media combination, integration in objects; body mounted devices</i>)	3	1	3	1	4		1			2	15
Interlink trajectories (<i>with communication and awareness services</i>)	2		3	2	1						8
New Communication media to connect people (<i>new forms of connections via tactile media, sound, video or combinations</i>)	2		3	3	2				1		10
Visualisations of communication behaviour and awareness building			1			1	1				3
Design concepts to manage chronology of mediated communication						1	1			1	3
Design concepts related to the described practice (<i>work tasks or to the relationship itself</i>)	4	1		1	2			1			9

Table 6.1: The analysis of overall 37 design proposals led to seven categories of concepts' attributes. Each design concept was characterised by one more of these attributes.

Designers also proposed services that would make users aware of other people's trajectories, their activities and experiences. This was especially the case for proposals in response to curated Probes from probing experiment one. These instances of mobile relationships emphasised two intertwined trajectories. This

resulted in the design of concepts that envisioned new connections between these two trajectories. Curated Probes from the second probing experiment instead showed how individual mobile workers dealt with their mediated communications over time. This single trajectory perspective triggered a higher number of design responses that aimed to visualise and manage the chronology of mediated communication over time.

The Probes also triggered design concepts that referred directly to the described work tasks or to people's relationships, e.g. to the content of the couple's communication. For example, a design concept (in response to MWC3's Probe) proposed to use statistics about the respondent's service maintenance performance that could be communicated to his clients. Although these concepts deal with mediated communication as well, they are intrinsically based on a specific task or content of interaction.

The following sections will present these findings in more detail and introduce examples from both types of analysis (analysis of the design process and of design concepts).

6.3 Results: Discussion and Details

This section provides an extended discussion about mobile interaction trajectories' value to inform and support design processes. These sections draw on the results coming from both types of analysis that have been discussed in this chapter so far.

6.3.1 Trajectories

Mobile interaction trajectories situate mediated communication in everyday trajectories. The analysis of the design teams' processes showed that this informed the design processes. This finding emphasises the value of capturing and displaying corporeal movement across *several locations* for generative design. This was especially the case with Probes that show a clear repetitive physical movement pattern, like Probes that indicate pattern-like paths, such as walking to work and back.

Respondents' trajectories made designers wonder whether they could change the movement pattern that the Probe described (when they thought that it was worth changing). The design teams envisioned mobile services and devices that could

change a person's trajectory – leading to new (mediated) communication habits. The proposed design concepts aim to trigger respondents to organise their everyday trajectories differently. Designers, however, also aimed at providing communication services to enhance the trajectory's experience, but without aiming to change the trajectory itself.

For example, the design team in workshop E perceived MWC5's movement pattern as rather standardised and monotonous. This impression made them think about changing this recurrent daily trajectory. Designer E2 reflects: *"If he is not happy with his many routines [note: refers to everyday journeys to work], then we can put something new to his life to make it a bit more fun. Sometimes you do the same routine but you feel different about it. It is like changing your clothes every day, which makes you feel a bit different."*

Another example, taken from workshop F, indicates a similar aspect about the described trajectories that influenced the designers' thinking process. MWC2's space-time diary showed two offices. The respondent indicated roaming in between these two places on a daily basis. MWC2 reported that during some days she changed office more than once a day. She was involved in different projects and the work required her to do so. She needed face-to-face contact with her co-workers. Looking at this curated Probe designer F2 reflected: *"Maybe what would be good for her to separate the work. I don't know if she can rearrange her timetable differently. It is kind of a pity doing all the back and forth."* Designer F1 responded: *"She seems to enjoy it and it can't be that far away. Maybe it is a good thing, because face-to-face communication is really important."* In this case this vision did not have a strong impact on the process. Nevertheless, the example shows that people's everyday trajectories can trigger design proposals and discussions.

6.3.2 Particular places to design for

The second valuable aspect of respondent's trajectories was that they identified a range of places that people go to on a day to day basis, showing how they semantically relate to each other. The completed Probe revealed places, or combinations of places, which respondents transitted or inhabited. The reported trajectories pointed at these places and designers explored them for potential design interventions. The highlighted places turned into scopes for design⁵⁴.

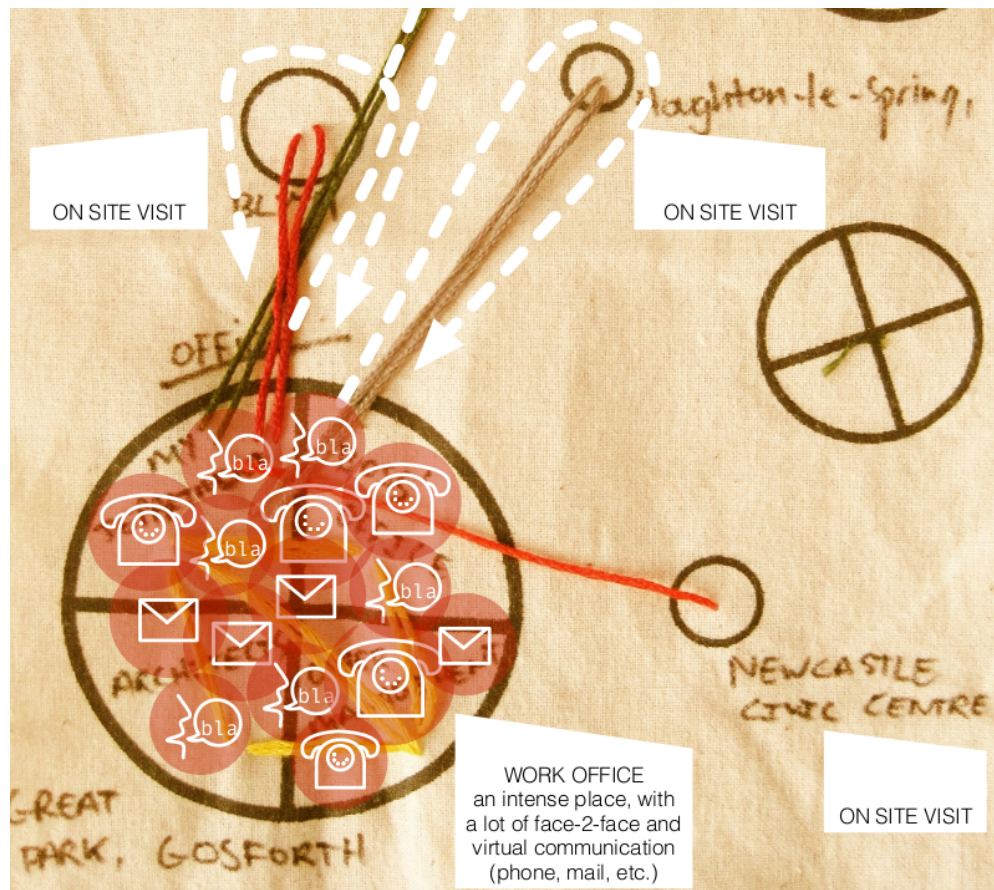


Figure 6.5: MWC5's busy office and his relieving escapes are another example of a place that work with space-time diaries could identify. Design teams used this insight for their work.

The work with MWC5's curated Probe (see figure 6.5) revealed an example for this Probe function. This episode shows how the characteristics and experience of a place informed the designers, helping them to decide at which place they should intervene. The respondent described his office as a busy place, where he continuously roams around to meet and to talk to co-workers. MWC5's curated

⁵⁴ The respondents' feedbacks and also the Probe's curation for design workshops sharpened these scopes and foci on particular places, which promoted some places more than others. The qualitative analysis however showed that even these curated instances of mobile interaction trajectories allowed enough freedom for design teams to negotiate the place for their design intervention.

Probe also displayed the respondent's repetitive travels to construction sites, which he described as relieving escapes from his busy office. His space-time diary helped to identify this contrast between the two places, which informed the design team's process. They wondered about where to intervene and discussed which places they should primarily focus on with their design concept. Designer 2G said: "Maybe his car trip is sacred and we don't touch it. It is quiet and peaceful. We should not change it." In this session the design team finally decided to concentrate on the respondent's busy office context. They proposed different concepts for visualising the intensity of online communication to a person's co-workers. To reach this point, however, they first negotiated whether the office was a good place to design for at all – next to other potential places they could have targeted.

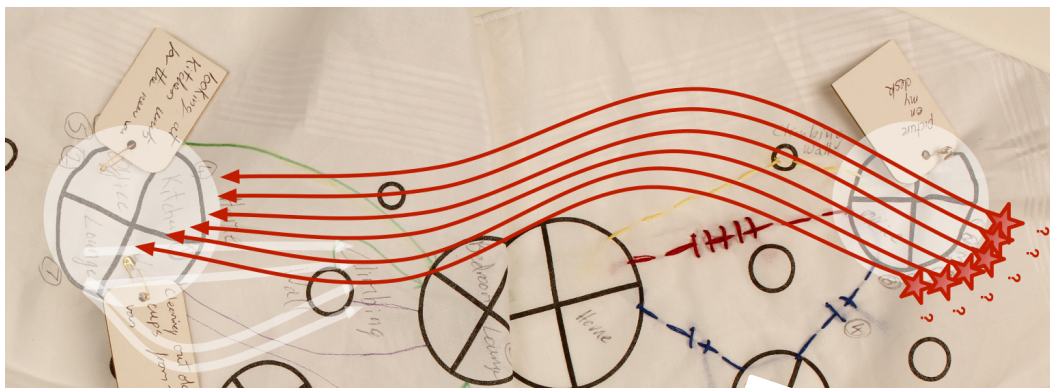


Figure 6.6: Probe work with MRS4 identified two interlinked places. The space-time diary emphasised this dual contextual focus and made designers deal with these insights involving multiple locations.

Other curated Probes highlighted *situations highlighting two interlinked places* as a focus for design (see Figure 6.6). This is a result of the try's aim to explore mobile communication in the context of interlinked trajectories. Hence, the Probes invited designers not only to design for one place, but rather they identified a *combination of interlinked places*, that belong to different people's trajectories. A prominent example is found in MRS4's Probe. The couple's space-time diary shows both respondents' work offices. These places appear as connected to each other through various text messages. The female respondent indicated that she started sending text messages to her boyfriend at 10 o'clock in the morning. Their space-time diary indicates this repetitive connection between these two places over several days, showing a particular chronology of mediated communication. The Probe's curation for design workshops highlighted this dual-contextual situation and provided a starting point for design. The aspect worth mentioning is that in this

case the attention does not lie on one single location only, but on a combination of places that are connected to each other via mediated communication.

The following discussion in design session G shows how designers made up their mind to decide at which place they should intervene:

G2: ...We could say it's interesting. We could break these patterns. Why would he feel the necessity to leave it [note: his office]. Does he get to a point where he goes: 'Now I have to go, because otherwise I am getting crazy'?

G1: Exactly. [note: reads out a Quote] 'I can only work on something for maximum of two hours, then I either have to go speak to someone...' [note: reads, and laughs]. He is chasing up people... he drives for one hour.

G2: He says it's quite, it's peaceful.

G1: Yeah, in the car.

G2: So, the rush from people running in and out... that was sort of our assumption too.

Then I am thinking we should disturb it in the end [note: the rush and hectic situation in the office], instead of designing for this place. I will just say what I am thinking. First, we were saying to enhance this [note: his communication in the office], because somehow he really prefers ...

G1: ...he prefers the voids.

D2: For some reason he prefers to leave this place because it is too hectic and visually we can see it, because it is "brrrrttt" [note: points at the space-time diary on the hankie]. [...] Here it is less hectic, here you have time to make these phone calls.

D1: ...and he could call some of these people when he is running around [note: in the office] all the time, but he could call them from here [note: during on-site visits], when he is in peace, and in this quite place.

D2: Maybe this car trip is sacred. We don't touch it. We say the car trip is still yours, its quite and sacred and peaceful. We do not change it. That's the moment when you can have your peace, right?... I am just talking out loud... I won't say it should be like this...

Iterating design concepts for different locations: The described trajectories had another influence on the design processes too. Insights about trajectories and places offered examples that helped to imagine location based software behaviours across the described places. Similarly, the awareness of places and how people roam between them helped designers to imagine and explain how a design proposal plays out over time. For example, designer 2B's (Figure 6.7) conceptual sketch describes how the proposed design concepts work for respondents' trajectories. The space-time diary therefore helped to explain and elaborate a design concept. This shows the space-time diary's evaluative and explicatory function.

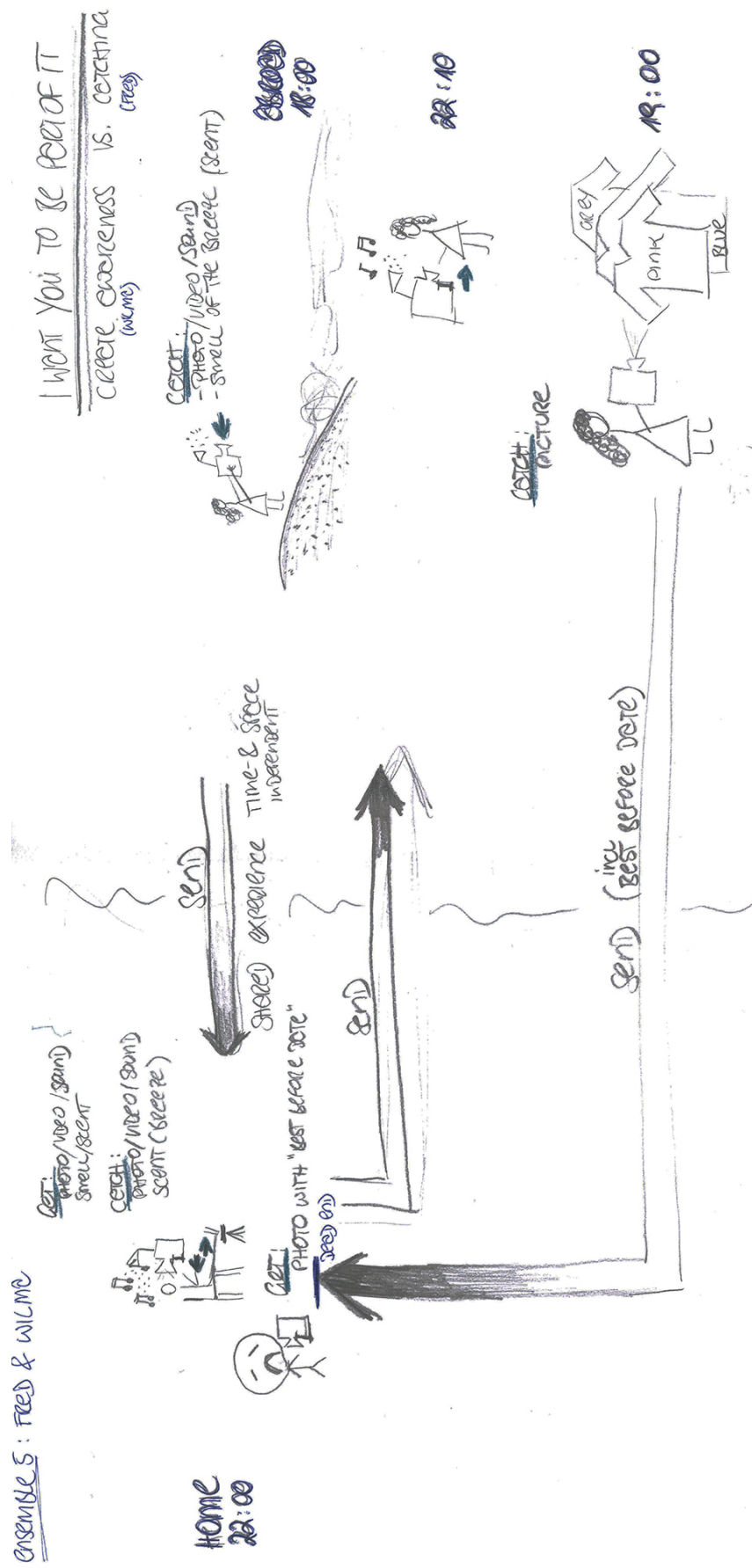


Figure 6.7: Designer 2B drew out a map how she imagined her design proposal to work. Clearly visible is the time span of her proposal on the right and the flow of information over time and space.

6.3.3 The experience of a place as design reference

The Probe debriefing interviews revealed a range of contextual experiences, which the space-time diary, as well as respondents' quotes, explained. These experience accounts formed a design reference, which inspired designers to imagine design concepts that achieve a similar experience, or that can enhance this experience. In doing so, the design teams did not necessarily focus on the place that the respondents described. Rather the place experience turned into a reference that informed the design process on a more general level. The following example will highlight this aspect.

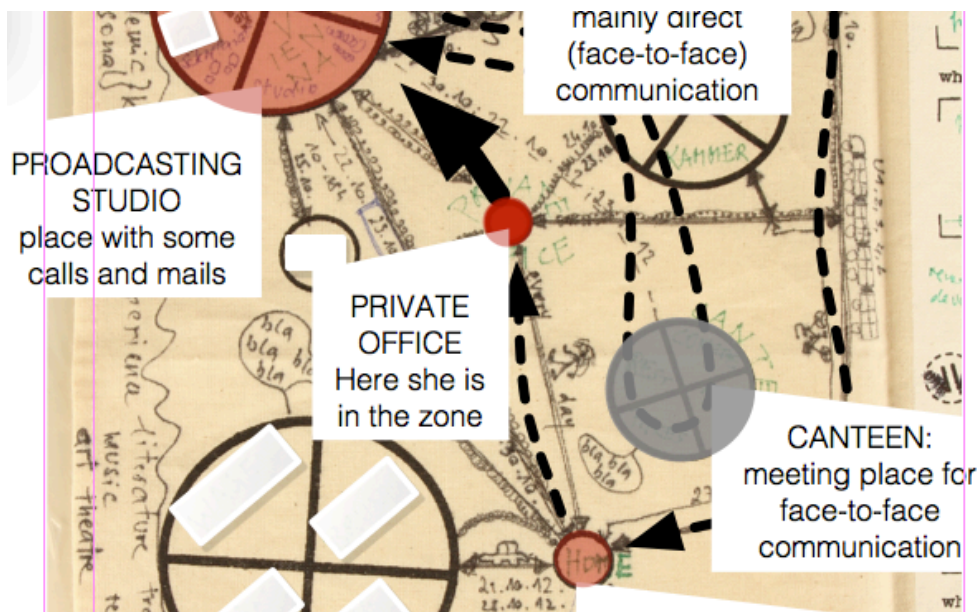


Figure 6.8: MWC1's space-time diary included her 'private office'. This is where she finds the most favourable conditions to conduct her work that included intense mediated communications.

MWC1's indicated that her private office is highly relevant for her work. In this room next to her flat, she is able to concentrate on work properly and she has all the necessary resources available to her. She chooses to work in this place as it shields her off from disruptions. In terms of mediated communication however, the place is intense. She writes emails, phones people and researches on the Internet. The place provides optimal conditions for these virtual activities. In workshop G, designer 2G called this place MWC1's "save haven" (see Figure 6.8). They concluded that many people have such a place and developed the notion further. They turned it into a design reference, which they used to inform their design. They adopted their understanding of *shielded-off-places* as a core thought for their subsequent design process. They did not design for the actual place that was described, rather using the reported experience to guide their work at a more general level.

The following discussion in design workshop G displays how the design teams develops a notion of shielded-off places, which they later use as a design reference:

G1: *Yeah, he seems to enjoy it. I think these kinds of activities would be nice for a lot of people: Cut-off all the communication. It is disrupting the work a lot. Just being kind of isolated, in a bubble somewhere* [note: draws a circle in the air].

G2: *Then it is similar to the previous example. She has this 'save heaven'... you know, you always have that place where...*

G1: *...but here it is the other way round...*

G2: *Yes. For the other woman it was the office, but for him it is the on-site visit.*

G2: *Hmm. Then I would not see this as a design opportunity, because this seems to work. I would not intervene there... I would not suggest: "Take your phone calls here."* [note: during the on-site visits]

G1: *We could rather enhance it, so that more people can do this* [note: take enjoyable and relaxing breaks from work]. *A work place concept.*

G2: *I mean, ok. At least that is interesting... that we saw in this example, people for some reason, have 'somewhere' where they are really able to purely focus on what they are doing, or in this case even that they like to shut-off, and really go at the desk.*

6.3.4 Interconnecting trajectories

The use of intertwined trajectories led to design concepts that aimed to introduce *virtual synchrony* and *awareness* about distant people's activities and moods. This was especially the case for design concepts in response to curated Probes from the mobile relationship experiment (probing experiment one). These Probes presented two interlinked trajectories from the outset. Thus, a number of resulting design concepts aimed for new ways to connect these trajectories with each other. Some of these design proposals aimed to interconnect the two trajectories on a practical level. Designer 1B, for example, suggested a concept for couple MRS1 that would allow them to discuss evening leisure and cooking activities during the day. Figure 6.9 maps out the designer's approach in synchronising the couple's decision process during their day.

Another example comes from workshop D. Designer 4D worked with MRS3's curated Probe and envisioned a service that can create awareness about the emotional state of a distant person. She proposed an interactive radio, which changes volume dependent on the emotional state of this distant person. According to the designer this could help choose the right moments to contact each other during the day.

6.3.5 Contextual adaptation

The Probe asked respondents to collect contextual characteristics about each moment of connectedness (via note-taking forms on the Hankie Probe). Although the completed and curated Probes expressed these insights with different granularities, this aspect revealed insights about the places and locative contexts that respondents use to communicate in. Design teams used these observations to inform the generative design processes.

Contextual artefacts as a design reference: Contextual artefacts, e.g. products and objects that were reported to be used in particular places, were utilised as a design reference, which informed the actual look and feel of a design concept (e.g. the form of a hardware device). Such artefacts constituted a reference to envision the actual appearance of a design concept.

For example, MRS1's Probe highlighted their use of post-its for informal notes that the couple leaves to each other on the kitchen table. This insight inspired the design process. Two out of three designers who worked with this curated Probe, picked up the concept of sticky notes. Figure 6.9 displays two design sketches that both show these artefact's influence on the proposed concepts. However, the designers did not use the post-its' form and function directly. Rather, they adopted the broader notion of post-its and were inspired by the purposes they are used for, but also by their tangibility. One presented concept foresaw a little printer that could receive and print messages. In this case the post-its' materiality, their size and also the purpose was mimicked. The designer's notes on her drawing sheet list the sticky notes as an inspirational source.

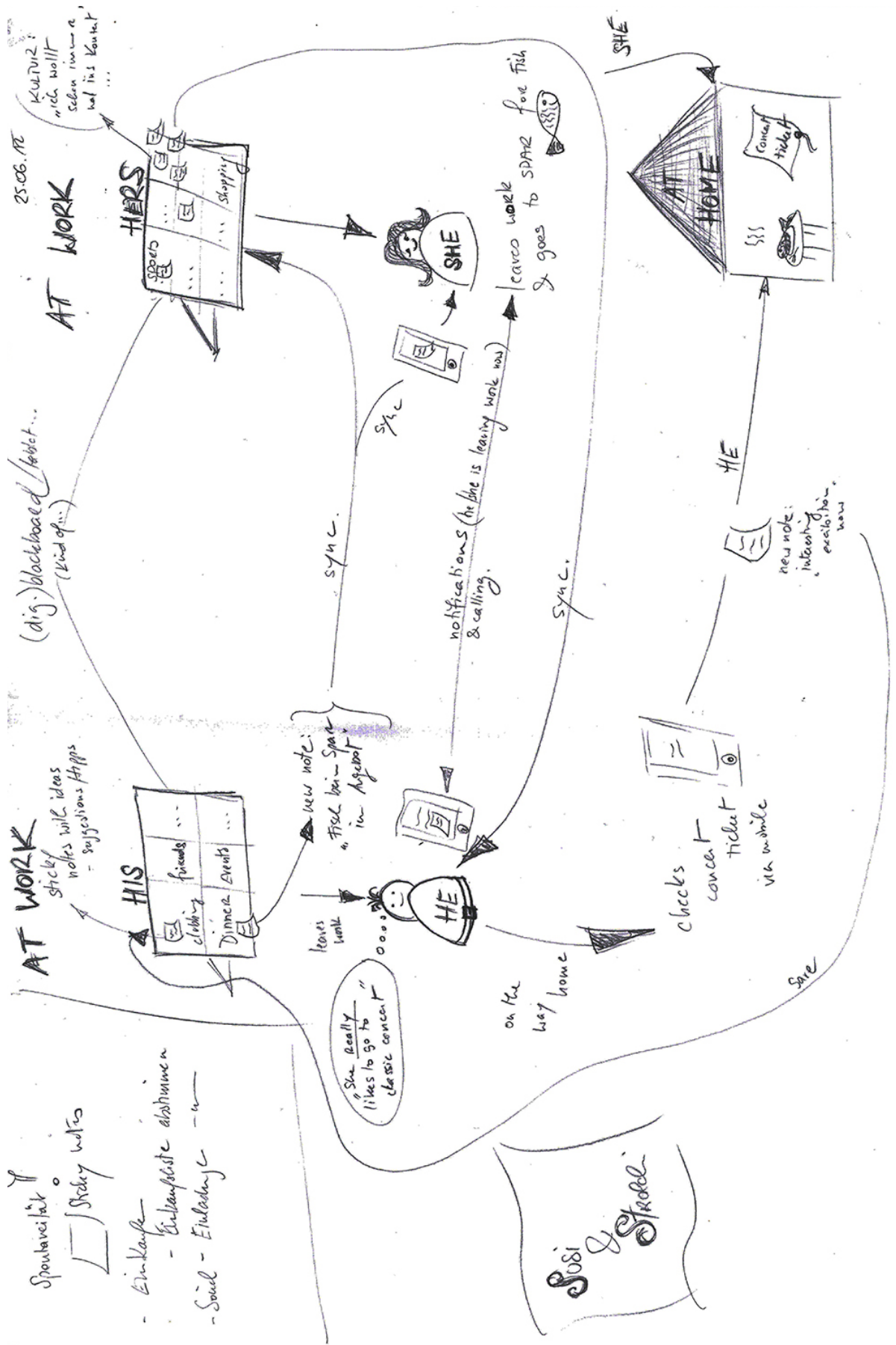


Figure 6.9: Designer 1B drew out a map showing how her design proposal would integrate the couple's trajectories and presented a story that explains how her design concept.

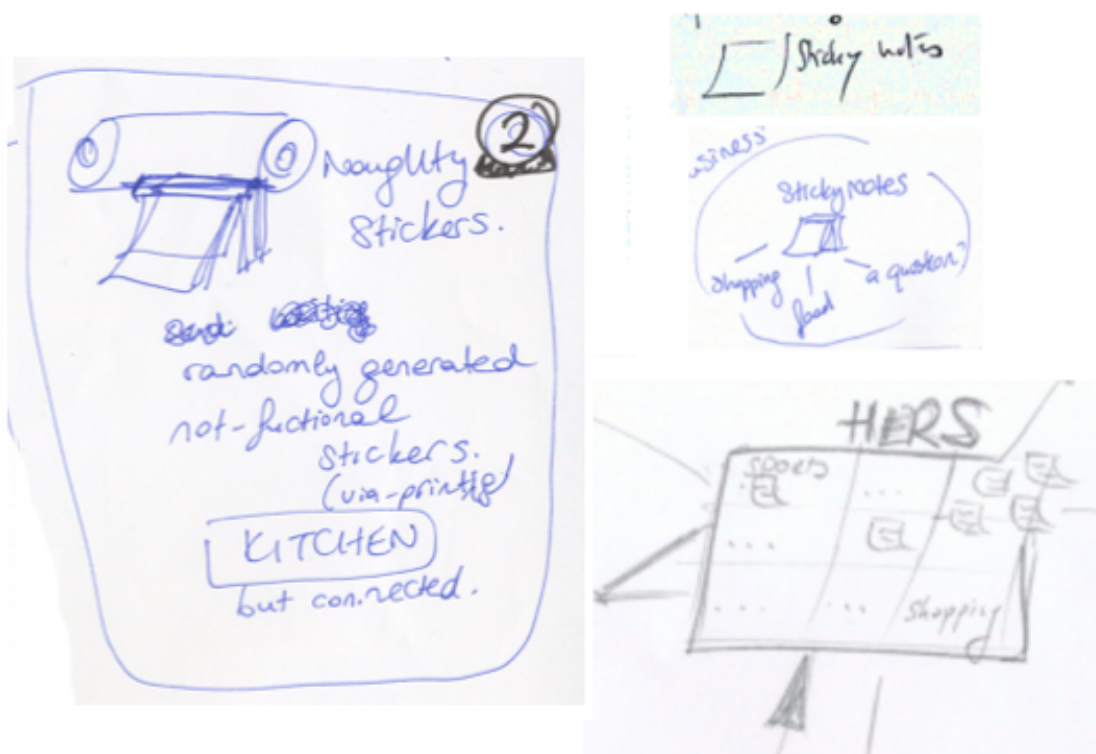


Figure 6.11: The fact that couple MRS1 talked about sticky notes, which they would use to leave messages for each other in their kitchen, directed designers creative process.

The following quote from Designer D4, who responds to MRS3's curated Probe, exemplifies the use of insights about contextual artefacts:

They [note: the couple] talk about jewellery. So they could get some haptic feedback. They say they write texts like "I miss you and bla bla bla". But relationships are a lot about 'touch'. So I thought it would be interesting to have something that uses haptics [note: feedback]. For instance, she could touch her wristband, and he gets a feedback. This, I think, could be more unobtrusive, compared to a text message.

Designers also made use of body-mounted devices to contextualise communication technologies. In this sense, design teams appreciated the respondents' bodies as another form of contextual artefacts. For example, designer 1C proposed a system that made use of haptic feedback (Figure 6.12). This is a new medium for communication, but also a contextual adaptation allowing a more seamless interaction with each other over time. The communication becomes less dependent on contextual situations.

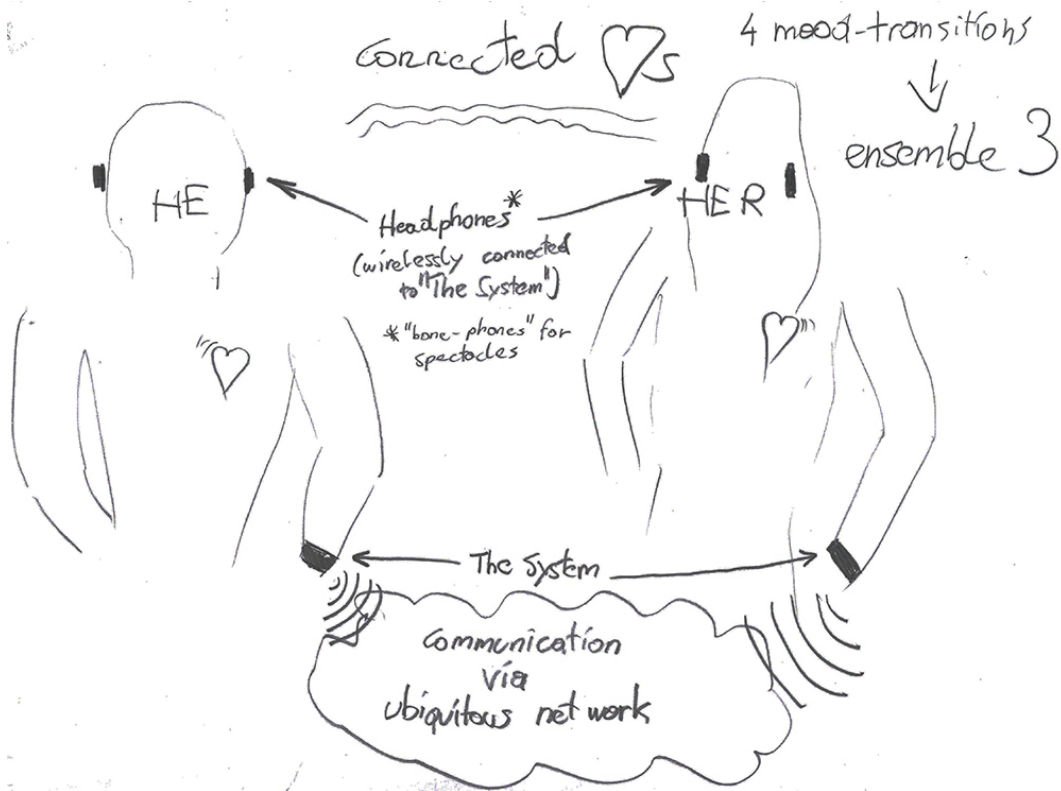


Figure 6.12: Body mounted devices that embed connectedness better across different contexts.

Adapted communication services and devices: Contextual adaptation however was not only achieved by integration into contextual artefacts or by mounting technology onto people's bodies. Design concepts aimed to combine existing devices and services in new ways to fit communication with people's changing contextual circumstances. This type of design concept responded to the contextual characteristics of communication in various contexts of everyday life. The proposals suggest adapted versions of existing and broadly used media devices and services, although in new, combined and adapted forms. For example, designer 2B suggested a combination of different communication modalities and media to embed a couple's interaction with each other into their everyday activities (see Figure 6.13).

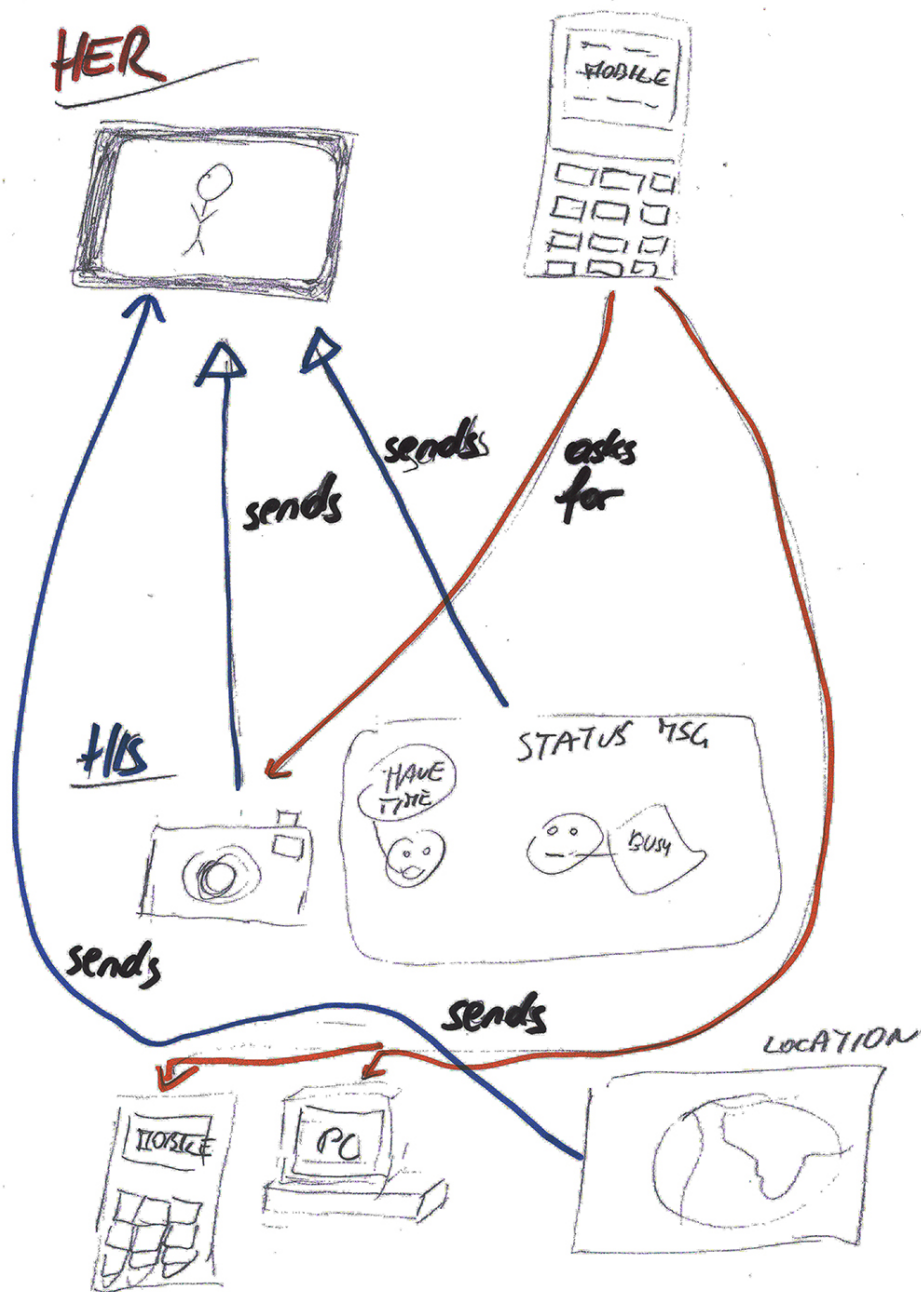


Figure 6.13: A conceptual sketch by designer 2B, who proposed a recombination of already existing media as a response to couple MRS5's curated Probe

6.3.6 Designing new communication media

The curated Probes inspired design concepts that leverage new communication media. These designs aimed to introduce new experiences of being connected by providing new media channels through which a distant other could be experienced. However this does not primarily mean changing the timeliness (when) or locality (where) of the communication. Rather, it aims to change *how* communication technology allows people to perceive and experience each other.



Figure 6.14: Write-on-the-hand concept. Writing an email on the receiver's hand will - hopefully - lead to a stronger presence of the email in the target context (drawn by the thesis author, based on the design teams accounts)

An episode in workshop G emphasises this aspect. MWC4's curated Probe spoke about an annoying communication experience. During Probe completion the respondent had realised that he repeatedly contacted the same person over and over again to obtain one single piece of information. He started with email, but then had to change to phone calls in order to make the person respond. MWC4 reflected that people seem to treat incoming emails in peculiar ways: They push them aside and don't get back to them for a while. He hinted at emails' significantly low impact. In the debriefing interview MWC4 concluded: *"This is how it went on a few times. This annoyed me, because it was the first time I took notice about this."* Designers in workshop G concentrated on this point. It made them talk about the effectiveness of different media. They discussed the appearance of incoming emails compared to the impact of face-to-face communication or phone calls. The most interesting concept that came out of their discussion was a system that writes email messages onto the mail-receiver's hand (see Figure 6.14). This turns the

messages into tattoo like reminders, which school children use to remember their homework. From a design perspective, this concept does not change the timeliness or the locality of the communication, but introduces an adapted media that alters the message's intrusiveness and consequently the experience of mediated communication.

6.3.7 New chronologies for being connected

The analysis of design teams' processes showed that working with mobile interaction trajectories inspired design concepts that change, disrupt or rearrange the chronology or locality of being connected to distant others. Thus people can connect to each other at new times, in new places or with a different chronology. The reported practices with communication technologies during moments of connectedness, as well as people's physical movement patterns, their communication routines and chronologies of mediated communication, significantly influenced this design direction.

A passage during workshop B explains this relationship between reported practices, moments of connectedness and the aim to introduce a new chronology of being connected, allowing people to communicate to each other at new times and in new places. Designer 2B worked with couple MRS5's curated Probe. MRS5's Probe shows the couple's communication during a weekend that they spent separated from each other. She was travelling, while he spent the weekend at home. During the entire weekend she updated him with little stories about what she was doing, what happened to her and her experience of these events. Apart from a few phone calls she primarily used text messages. He instead had problems with catching up with the number of messages she sent to him. With the following comment designer 2B interpreted the couple's experience and pointed at a potential problem: *"She is travelling and has got the feeling she wants to tell him about her impressions and also her emotions. And he is a bit overwhelmed, I think. He has to deal with everything she is experiencing."* The designer proposed a service that accumulates status messages in a story-like way that he can consume in the evening of each day. The designer argued that this concept would require him to be less responsive and could also lower his feeling of having to be reachable all the time. She instead knows that her messages would eventually be read and does not wait for an immediate response. The design concept changes the communication's chronology and locality by introducing asynchronous communication (also see Figure 6.7).

The following discussion amongst design team H that worked with couple MWC1's Probes further shows how the Probe instances directed designers towards thinking about chronologies of communication:

H1: I mean, she does look very organised... focusing on the mail stuff [note: at particular times and in particular places of a day]. What if she could push her mails to moments, situations or places or whatever... ?

H3: That is basically what she is doing in some way...

H1: Yeah, but you go through your mail and you think: that for later, and that for later... and every time you check the list you have all the mails there again.

H3: She probably needs something like that, for more than email, imagine she has a fair amount of phone calls.... coming in and going out... I mean, she needs to juggle different types of communications, in a way. In a couple of these places she cannot deal with any of them...

She has meeting places.... In the broadcasting studio she has limited possibilities [note: to take calls] and stuff like that...

H3: Maybe she has strategies for all types of these communications... Calls that she can't take, and then come back to them, call people back... [...]

H1: ...but she does not say that she has a way to organise that... she just says she leaves things for later...

H3: That is a way!

6.3.8 Manage and visualise virtual commitments

Designers also used another strategy for changing and improving the described situation. They proposed concepts that make people aware of their own mediated communication practices, routines and chronologies. This is a more implicit strategy for inducing change.

Visualisation of the dynamics of hyper-connectivity: A small number of design responses focused on visualising the dynamics of mediated communication the curated Probe described. These concepts' purpose is to convey a sense of density of mediated communication. For example, designer 3A decided to provide an ambient display in response to MRS3 (see Figure 6.15). His sketch shows a rough concept to visualise the imbalance of the couple's communication to both partners, e.g. the number of text message conversations one instigates. The visualisation should make them reflect and act. In the long, run the concept's aim is to ease their experience of an imbalanced communication that they had reported.

Workshop E also resulted with a design concept that aimed to visualise the chronology of mediated communication. Working with MWC1's Probe, the design team imagined email inboxes to transform visually on the screen (See Figure

6.16), according to the number of incoming emails and dependent on the place the user goes to.



Figure 6.15: Designer 3A envisioned an ambient display, which shows the amount of instigated communication of each partner. The concept aimed at creating more awareness.

Manage hyper-connectivity and the chronology of mediated communication over time: This category of design concepts is similar to the one described before. It also summarises concepts that deal with hyper-connectivity. However, these concepts go beyond creating awareness, foreseeing the target users' role as more active. The proposed design concepts enable the target users to actively manage their virtual commitments through different technological means. The following examples illustrate this attribute.

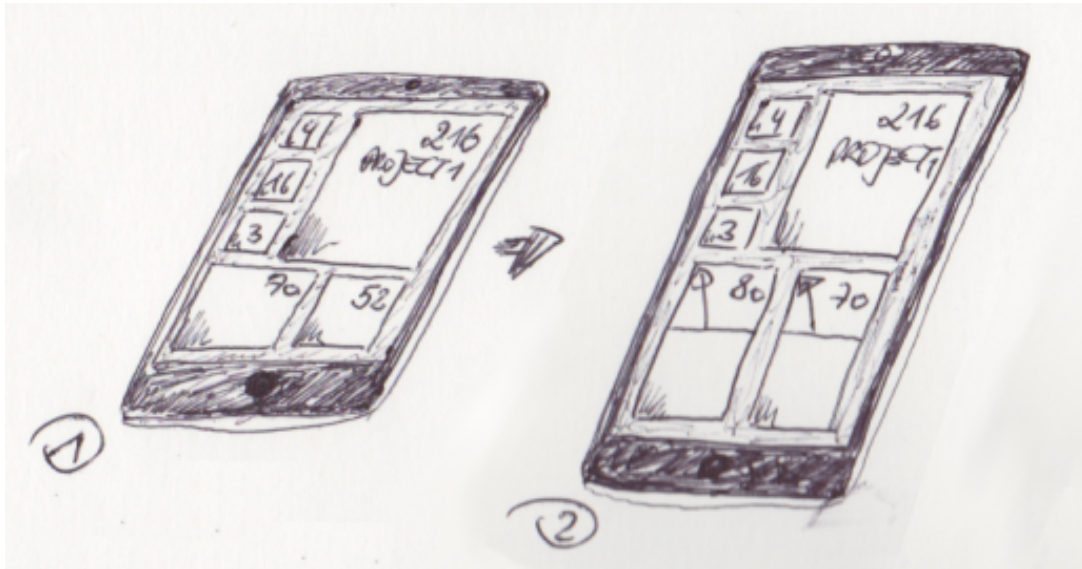


Figure 6.16: Email inboxes re-shape visually to communicate the activity in different projects and according to the location someone goes to (re-drawn by the thesis researcher)

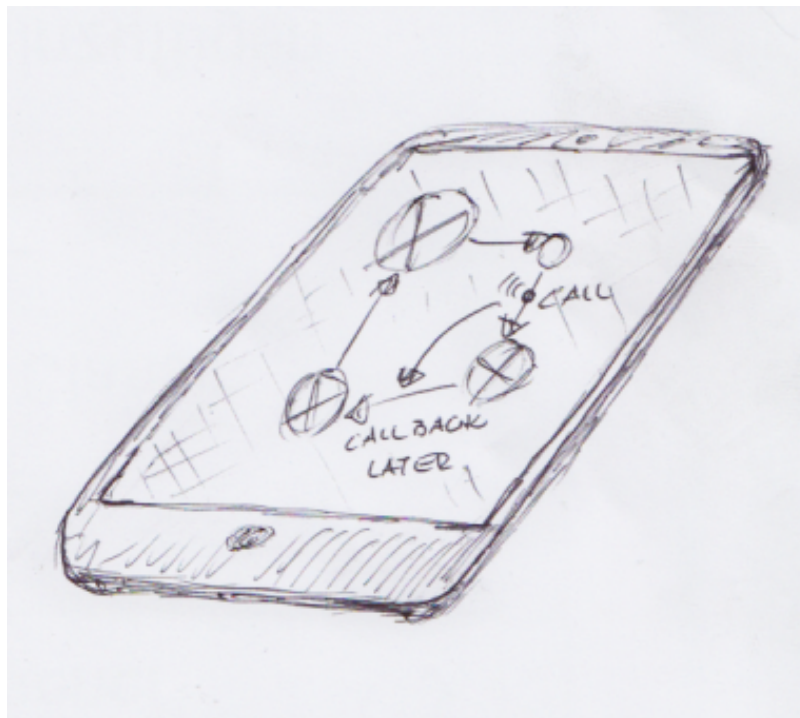


Figure 6.17: Users can drag a phone call to a specific location. Going to this place the application sends a reminder. The application helps visualising and managing communication in the context of everyday trajectories (concept re-drawn by the author of this text).

In workshop H, the design team proposed an app-like service in response to MCW1's Probe. The design concept is thought to run on a tablet PC. The application shows a person's individual trajectory; similar to the maps the space-time diaries indicate. Each incoming phone call and email (etc.) is located on this map. The user can shuffle these mediated communications in the personalised maps (Figure 6.17) reorganising their communications alongside their trajectory.

For example, one can drag a missed call onto a place and the application sends a reminder to return the call once one enters this place the next time. The application visualises one's chronology of mediated communication in the context of physical trajectories and allows active planning and management of mediated communication. Obviously, the idea is influenced by the space-time diary.

6.3.9 Design proposals supporting the work/activity

The actual work tasks and the couple's activities that the curated Probes and instances of mobile interaction trajectories introduced were a source informing design vision and concepts. Designers responded to these insights, with the primary aim of supporting these tasks and activities. The most prominent example in this respect is design team F's approach. They proposed a system for respondent MWC3 that presents positive statistics about the machinery he looks after. The designers argued that this app could be a positive mood-push for him, since he normally has to deal with clients' complaints. The design concept however, could also be used to convince his clients that he is doing a good job.

This design concept does not primarily focus on mobile communication and new forms of being connected, but rather draws from the work tasks the respondent reported on. Designing new communication media, or changing the respondent's mobile communication routine is not the central idea. The design concept nevertheless deals with aspects of mediated communication indirectly, because it is an intrinsic part of the respondents' work practice. Communicating statistics and using such information for staying in touch with clients can introduce new forms of being connected. However, in this case, this is only a result of the design concept's primary purpose, namely to provide statistics about the machinery.

6.4 Discussion: the value of mobile interaction trajectories for generative design processes

The overall insight of this chapter is that the curated Hankie Probes – which feature *instances of mobile interaction trajectories* - introduced a range of aspects that inspired and informed the generative design processes. The findings are summarised in Table 6.2.

Findings:	Contribution to Knowledge
<p>The work with mobile interaction trajectories led to design concepts with the following characteristics⁵⁵.</p> <ul style="list-style-type: none"> • Services and devices that <i>change the chronology</i> of being connected to distant others. • Communication technologies that show a high degree of <i>contextual adaptation</i>. • Communication services that <i>interlink</i> people's individual trajectories with each other. • Digital devices proposing new <i>media-formats</i> for everyday communication. • Services that help <i>manage and visualize</i> the chronologies of mediated communication. <p>Mobile interaction trajectories distinctive characteristics have shown to inform and inspire generative design processes.</p> <ul style="list-style-type: none"> • The middle range theory's <i>trajectory-based perspective</i> inspired and informed generative design processes. • The middle range theory's focus on <i>practices and experiences of changing states of connectedness, chronologies of mediated communication and mobile communication routines</i> inspired and informed generative mobile interaction design processes. 	<p>The middle range theory of mobile interaction trajectories inspires and informs generative mobile interaction design processes.</p> <p>Mobile interaction trajectories' trajectory-based perspective inspires and informs generative design processes through its focus on physical mobility, practices and experiences of changing states of connectedness, chronologies of mediated communication and mobile communication routines.</p>

Table 6.2: Chapter 6's findings summarising the mobile interaction trajectories value for generative design processes.

It can be concluded that **the middle range theory of mobile interaction trajectories can inspire and inform the creation of novel design concepts for mobile interaction design**, in particular in areas that seek to introduce new forms of being connected via information and communication media. This makes the middle range theory of mobile interaction trajectories a valuable perspective for framing and scoping insights about users and contexts for generative design processes. It introduces a fruitful theoretical alternative, with aspects that, for example, (single) location-centred perspectives in isolation, cannot offer, because they focus on one place/location from the outset - as discussed in Chapter 2. Furthermore, mobile interaction trajectories' focus on *changing states of connectedness, chronologies of mediated communication and mobile communication routines* also informed and inspired generative design work. This

⁵⁵ Design concepts that relate to the work practice or to the content of couples' relationship are not listed here. They do not directly relate to aspects of mobile interaction trajectories.

shows that novel mobility theories, in particular an everyday perspective on *fluid interaction* (Kakihara and Sorensen, 2002; Bell and Dourish, 2011), has value for mobile interaction design.

Apart from this general verdict however, the theory was found to offer particular value for mobile interaction design, which will be discussed in the closing paragraphs.

This chapter has reported new (and so far unexplored) aspects about contextual research in mobile interaction design. These novel insights stem from the middle range theory's focus on everyday trajectories. The analysis showed that design teams benefited from the example trajectories, which described rhythmic patterns of physical movement across several places and contexts of everyday life. There are three aspects that the generative design processes benefited from and which have so far not been discussed in the research literature.

First, respondents' trajectories, especially those showing clear and recurring movement patterns, triggered design visions that aimed to alter or enhance these daily trajectories by introducing new communication media. Second, the trajectories also offered interesting places (or combination of places) to focus the design process on. This formed a number of scopes for the design teams and allowed them to negotiate the place they wanted to intervene in. Third, the described trajectories helped the designers to imagine a design concept to play out over the course of a day and across several places. This guided the design teams in iterating, describing and evaluating their concepts.

Mobile interaction trajectories stress practices and experiences of mediated communication in the context of everyday life. In this respect the middle range theory describes people as having several moments (and periods) of connectedness during their individual trajectory. The analysis in this chapter revealed that designers drew from these insights. This finding constitutes a contribution to knowledge for the area of generative mobile interaction design as well. However, it is not the case that the middle range theory of mobile interaction trajectories first emphasised or discovered these aspects. Over the last several years a range of research papers described (new) practices and experiences of being connected by means of currently available communication devices, like Ito and Okabe's (2005) or March and Fleuriot's (2006) work about teenagers'

communication practices and experiences with text messages. What this thesis has done, however, is show that these insights expressed via routines and chronologies of mediated communication are a direct source that can inform generative design processes. Furthermore, the research revealed that this type of insight influenced the articulation of design visions and design concepts towards changing the chronology of being connected, and towards intervening with new and contextually adapted communication media.

Further, the analysis revealed the relevance of contextual characteristics for generative mobile interaction design work. Contextual research, like Iacucci et al.'s (2000) or Pledell and Vetere's (2005), highlighted the importance of contextual characteristics for informing and inspiring mobile interaction design processes. In this respect, this thesis research confirms these authors' findings, but adds another layer of granularity. It shows how insights about contextual characteristics function during a design process. The analysis revealed Probe respondents' reported contextual experiences and contextual artefacts to act as *design references* that create design visions and influence the look and feel of design concepts, e.g. the physical hardware design.

These insights are extended and contextualised by the two following chapters. Chapter 7 will explain the design teams' processes with the curated Hankie Probes discussing how they dealt with the resource and with the insights about users and contexts that were presented to. Chapter 7 also reveals other influences on the design teams' processes. This allows assessing mobile interaction trajectories' value in design workshops more broadly. In addition, Chapter 8 will show how the Probes' handmade and fabric-based format influenced the work with the curated Probes.

Chapter 7: The characteristics of the design process with curated Hankie Probes and other influences

This chapter presents an extended overview of the design processes with the curated Hankie Probes in design workshops, relating Chapter 6's findings to a broader perspective. It draws from the same data sources and applies the same processes of qualitative data analysis. The analysis supports the thesis' secondary research strand: *The characteristics of the design process with the curated Hankie Probes and other influences on design teams' processes.*

The chapter analyses the critical incidents already identified in Chapter 6, albeit from different angles, resulting in three additional types of analysis:

- 1) The nature of the design process with the curated Hankie Probes. This shows how designers worked with presented insights about users and contexts.
- 2) The influence of designers' experience and background during the design process.
- 3) Other aspects of the curated Probe's design and presentation that informed the design process.

The **first analysis** in this chapter discusses the curated Hankie Probes' role as part of a *pragmatic design process*. This is motivated by a lack of theoretical understanding of the design process with Probes in the literature. Similar to Chapter 6, for this particular analysis the chapter draws from three concepts: *insights about users and context*, *design concepts* and *design visions*. As described in *Chapter 2 Contextual literature review*, these three concepts stand in close relation to one another. I will examine the design workshops with the Hankie Probe to understand the design process from a theoretical point of view, as well as to examine the Probes' role as part of this process.

The **second analysis** in this chapter will discuss the influence of the designers' experience and professional backgrounds during the design process. The analysis of several critical incidents revealed the designers' input as a crucial aspect for the articulation of design vision and design concepts. The discussion will show that designers interpreted and augmented the presented insights about users and

contexts with their own subjective experience. The discussion also shows how designers used their experience in designing interactive technologies to transfer a vision into an articulated design concept.

Further, the analysis in this chapter discusses other influences on designer's work with the Hankie Probes. This revealed a number of aspects that designers drew from to explore the presented insights about users and contexts, to articulate design visions and design concepts. For example, the drawn and stitched space-time diary appeared to be a central entity with a relevant role in the design workshops. It acted as a central anchor point to explore the Probe and get a first impression of the instances of mobile interaction trajectories.

This chapter uses a broader frame to complement the presented findings on mobile interaction trajectories (Chapter 6). It shows that the presented instances of mobile interaction trajectories set the scene, but were enhanced by a range of influences within the design settings, which teams drew from. It further shows that using space-time diaries to express mobile interaction trajectories guided design teams towards design concepts related to respondents' trajectories and locative contexts.

The results of this chapter, however, also contribute to knowledge in the area of design processes with Probes. Probing is mainly understood as dynamically framing a researcher-respondent relationship. An explicit analysis of Probes' functions in the design process is missing. This chapter articulates a new theoretical interpretation of design processes with Probes (grounded in empirical evidence).

7.1 First analysis: The nature of the design process with the curated Hankie Probes

I first examine the curated Hankie Probe's role in the design workshops, using a theoretical model of design processes as an interleaved process of synthesis and analysis. This first analysis explores how the curated Hankie Probes related and contributed to such a process.

7.1.1 Method of analysis, data sources and process of analysis

For this analysis, I examined the protocols of design workshops E to H. These protocols document the entire design process from start to finish. The transcripts therefore document the evolution of the design concepts, and also how design teams worked with the instances of mobile interaction trajectories. I looked at the critical incidents that the analysis for Chapter 6 had already identified. In this analysis, a critical incident was identified whenever a designer articulated a *design vision* or a *design concept*. These concepts were defined in Chapter 6 (*Section 6.1.1.2 Insights about users and contexts, design vision and design concepts*). Contemporary design theory explains *design visions* and *design concepts* as emerging in a recurring solution-centred process (Löwgren and Stolterman, 2004) – as described in Chapter 2. Literature also suggests that the articulation of design vision and design concepts make designers focus on some insights about users and contexts over the course of a design process (Cross, 2006; Lawson, 2006; Löwgren and Stolterman, 2004). The on-going articulation of design vision and design concepts is often a response to insights about users and contexts, which advances the *understanding and the focus* on insights during the design process. The analysis aimed to understand how design visions and design concepts evolved in relation to the presented instances of mobile interaction trajectories, revealing the curated Probes' role in this interleaved process of synthesis and analysis.

For this analysis however, I did not look at each critical incident independently. Rather, I analysed how the articulated design visions and (evolving states) of design concepts in design workshops E to H build upon each other and how they evolve mutually throughout the design process. I then related the evolution of design visions and design concepts to the curated Hankie Probes. This was done by identifying thematic foci in workshops E to H. A thematic focus means that designers were discussing and focusing on a particular set of insights that the curated Probes communicated, e.g. they were discussing what the respondent does in one place that the Probe described⁵⁶. This showed how articulated design visions and design concepts related to the design teams' transient foci on insights,

⁵⁶ *Thematic focus on insights about users and context*: A focus on insights about users and contexts creates a specific scope on specific details in the presented insights. This focus guides a designer's exploration of insights presented via Probes. When designers focus on insights they actively (not necessarily consciously) include or exclude information/data/knowledge in the course of a design process, either temporarily or permanently. A focus on particular insights does not necessarily mean that the designers picked up and explored the Probe. It can be represented by a discussion only.

and vice versa how transient foci influenced the evolution of design visions and design concepts. It revealed the design teams iterative loops of synthesis and analysis in relation to the curated Probes and showed the Probes' function for the generative exploration of insights. Further, I analysed how often design teams changed their focus over time, which type of insights they typically focused on, and how focus changes influenced design visions and design concepts, as well as vice versa, if and how new design visions and design concepts led to new transient foci for exploring the curated Probes. Lastly, I examined if and how design teams used insights from the curated Probes for the synthesis and analysis of particular design visions and design concepts.

The following two sections will discuss the observed particularities of this process with the curated Hankie Probes.

Figure 7.1 explains the identification of temporary foci with an example transcript taken from workshop H (MWC2 Probe). In this excerpt, the design team tries to establish a *design vision* of how to respond to the presented curated Probe. The analysed transcripts of workshops E to H are documented by Appendix 6.1 and 6.2.

7.1.2 Results: An iteratively evolving design process

This subsection introduces the general nature of the analysed design processes with the curated Hankie Probes. This finding sets the scene for a broader understanding of the Probe's role in the design process presented in the next section.

The observed processes were characterised and driven by a search for a design concept in short iterative circles. The processes revealed a consecutive process of synthesis and analysis, which led to the articulation of design visions and design concepts. These stood in close relationship with particular transient foci on particular insights about users and contexts that the curated Probes communicated. This finding confirms the understanding of design work that contemporary design theory suggests (Cross, 2006; Lawson, 2006; Löwgren and Stolterman, 2004).

help re-arrange the time table (organise work day and prevent her from walking back and forth)

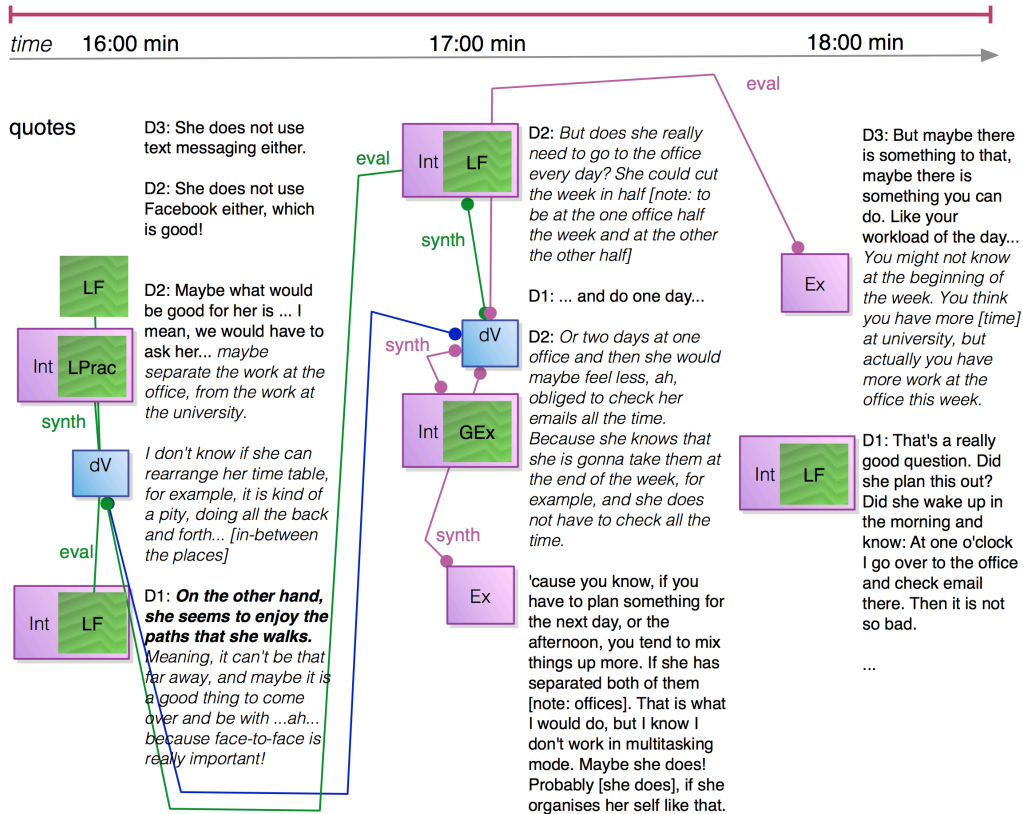


Figure 7.1: An excerpt of transcript protocol of design workshop H (MWC2): For this period the thematic topic was focused on 're-arranging' the respondent's timetable. The red line above the transcript indicates the duration of this focus during the design workshops. The protocol shows two articulated design visions (dV). They are related to each other, indicated by a blue line. Violet: the designer's interpretation (Int) and experience (Ex). Green: influential categories from the theory of mobile communication, which were discussed in the previous chapter.

A more detailed look at the design processes shows the interplay between transient foci, design visions and design concepts, which evolved in conjunction and throughout each workshop. During the work with curated Probes the focus on insights was consecutively negotiated and refocused by the articulation of design vision and design concepts. A transient focus on insights guided the design team's temporary exploration of the Probe.

The following paragraph will show one example of this interrelated and mutual evolution of vision, design concepts and focus on particular insight. This example is taken from workshop E. The group worked with MWC2's curated Probe. The design team had already articulated a design vision. The example documents the design team looking for a design concept for their vision to become materialised. The example shows how they change the focus on another set of insights, as their initial focus did not lead them to a satisfactory design concept.

The team worked on a design concept for an email management system that respondent MWC2 would find less distracting. The designers' *vision* was to design 'something' that makes the respondent access her emails with more purpose during the day. The group first sought a solution with a screen-based approach. Their first idea for a design concept was to make it harder to access emails, e.g. by hiding email-inboxes on the desktop. This was their first focus. The purpose was that MWC2 would probably refrain from checking emails 'all the time', if her email inbox was more inconvenient to access. They talked about ways to disguise the email icon on the screen. Hence, they worked on the actual design concept. After a short while, the team discussed the value of this design concept briefly. They were not convinced. Designer F1 concluded: "*All these things exist already.*" The design team dropped their idea. Then designer F2 opened up a new perspective on the curated Probe. This became their new focus. She looked at the Probe and stated: "*Maybe we can think of something that is tangible, that she wears or puts on. For example: a ring.*" With this comment the designer opened up a new focus to work on, namely the work with tangible objects for visualising information. The design team consulted the Probe and looked for objects and accessories the Probe respondent indicated wearing. The Probe showed that the respondent carried around a 'notebook'. This shift of focus opened up a new vision. As a result they started designing an ambient device to visualise the activity in different email boxes. They finished with a wearable ambient device that could be clipped onto accessories or cloths. The example documents a shift from one focus to the other, triggering a new vision. Further, the new focus led to the inclusion of new insights (in the Probe's content). In this particular case: tangible objects that the user carries around.

An example taken from workshop E illustrates this focus-shifting characteristic of the design process with the Hankie Probes. Figure 7.2 displays an abstracted version of a design process as it was recorded during design session E. It displays an iterative evolution of (shifting) foci, design vision and design concept. In addition, it also shows the relationship between focus (indicated by red arrows) and critical incidents (indicated by blue boxes representing design visions and design concepts). In this design process, the focus on *insights about users and contexts* changed five times over a 30 minute period. This pattern typically happened in each of the design workshops. Each focus that the design team embraced is typically related to a particular vision and/or design concept. In this example, the designers started by looking at ways to support the respondent's

work tasks. Then they decided to look more closely at 'email management'. From then on they explored visualisation strategies in three different ways. Each choice changed or channelled the focus for their exploration of the presented insights.

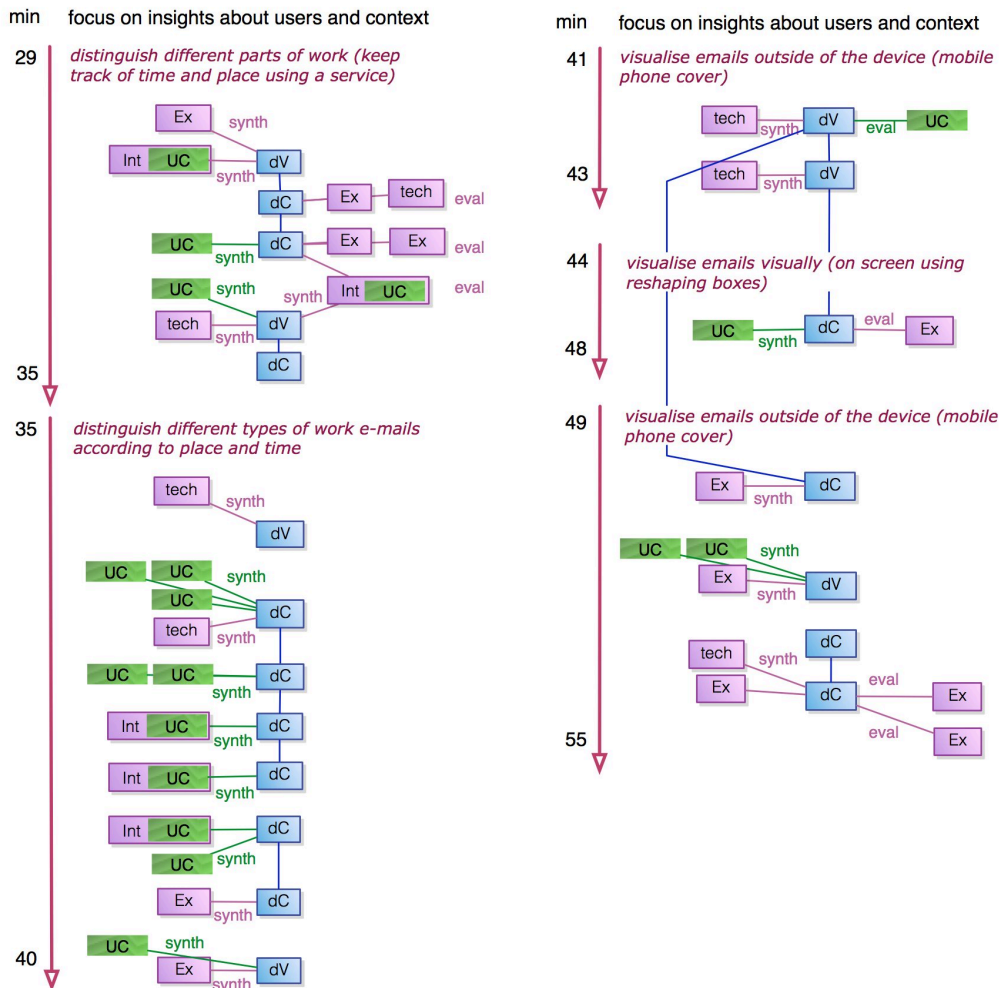


Figure 7.2: An abstracted visualisation of an excerpt of design session E: The protocol shows several critical incidents over 26 minutes of a design session. The red arrows span particular foci. The related design visions (dV) and design concepts (dC - stands for design concept) are indicated in blue. The figure shows at which points during the design session designers related their experience (dE), interpretation (dInt) and technological possibilities (tech) to each of these critical incidents. 'UC' stands for 'user context', which stands for aspects of the Probe that designers used to inform their process. An 'int' to the left stands for aspects of the Probe that were interpreted from a subjective stance in order to use it for the design process.

With this basic understanding of the analysed design processes, the next section explores the Hankie Probe's role in this process more explicitly.

7.1.3 Results: Theoretical frame, scopes and selectable reference point

The Probes' role in the course of this iteratively evolving design process was three-fold. The analysis suggests three types of Probe functions:

- The curated Hankie Probes provided a **thematically and theoretically framed** instance of mobile interaction trajectories.
- The curated Hankie Probes introduced a number of **scopes** within these instances.
- The curated Hankie Probes offered **selectable reference points** for synthesis and analysis (evaluation) of design concepts over the course of the design process.

These functions relate to typical characteristics of design processes as they are described by researchers such as Cross (2006) or Löwgren & Stolterman (2004), i.e. designers *framing* the design context according to their theoretical understanding and practical needs, designers exploring different scopes before focusing on one direction or designers progressing their concepts in short iterative circles. The following analysis shows that working with the Hankie Probes supported some of those design processes' core characteristics⁵⁷.

The Probe as a thematic and theoretically framed instance: The curated Probes introduced an instance of mobile interaction trajectories to designers that suggested the general frame for their exploration. For their processes, designers stayed within that frame. This finding is rather obvious and straightforward, since the Probes theoretical basis has been explicitly articulated in Chapter 5. It is however important to recognise this baseline function of Probes in general, which makes Probes appear as a landscape of starting points for the generative design processes. As such they act as what Löwgren & Stolterman (2004) call a *good foundation* to start a design process from. A *good foundation* neither needs to be *true* in a scientific sense nor a complete picture of users and their contexts. Instead, it is a manageable digest of the real world that fits the requirements and characteristics of the design setting. In the case of the Hankie Probes this *good foundation* is a result of mobile interaction trajectories' theoretical basis that is filled in and completed by the Probe respondents' feedback.

⁵⁷ Other design resources like personas, scenarios etc. may show similar traits. To compare the Hankie Probes, or Probes in general, with other resources is not the aim of this analysis however.

Several scopes within one curated Probe: The Probe suggested several scopes to look at, which the design teams explored. The following examples will show that these scopes are influenced by the Probe's theoretical framing, but are concretely established by the Probe respondents' reported details. For example, a typical scope was a particular *place* of mobile device use, e.g. a private office, a train cabin, a respondent's office, etc. Another prominent scopes were respondents' *practice* to manage multiple work commitments via email, a couple's *experience* of their particular communication chronology, the Probe respondents' *trajectories*, etc. Scopes were of different nature, resulting from the multiple perspectives that Probes offer. However, the design teams decided on which scopes they wanted to focus. The analysis of design workshops showed that the design teams explored a number of scopes in each workshop. The focus on scopes during each design process changed several times, typically from three to five times during each design process. This was a typical trait of all eight analysed design processes.

This scoping function describes what Löwgren & Stolterman (2004) call *divergence*. It is known that designers explore various options for a design concept before refining the detail of one. The curated Hankie Probe's several potential scopes supported this design principle.

Selected scopes provided a transient focus that the design teams explored. The design teams articulated design visions or design concepts in relation to such foci. At times, the focus changed due to a new design vision or design concept opening up new spaces to work in. Design teams then proceeded looking at a new scope that the curated Hankie Probes introduced, which became their new focus. The interleaved process of synthesis and analysis led to various focus shifts – depending on whether the teams found something worthwhile to explore or not. However, each group of designers differed in their approach. Design teams F and H used more time to explore the presented insights. They focused at a number of scopes broadly before exploring one particular scope of the Probe more thoroughly. They were more hesitant to seek a solution in one particular scope before having explored all other potential options. In workshop E and G the design teams were more straightforward in articulating design visions and design concepts. They articulated a design vision (or concept) for each scope they focused on and they spent less time exploring potential other scopes within the curated Probes.

The curated Hankie Probes offered selectable reference points: As part of this process, the curated Probes offered selectable reference points to synthesise and evaluate design visions and design concepts. Designers justified their concept proposals and evaluations by selectively referring to particular details in the presented insights. The analysis of critical incidents shows that such selective elements of the presented insights were used to synthesise and evaluate design concepts. These selective details can be represented by one or more (sets of) insights that a Probe presented, e.g. through a particular quote or experience account, through a particular drawing (etc). During the design process, the design teams referred to such particular sources of insights in order to argue for or against a design vision or design concept. Based on such small iterative loops, the design teams developed their design concepts further, or decided to change focus.

The design teams informed their iterative design processes by selectively consulting particular details of the curated Probes. This observed Probe function maintains the core characteristic of a design process, namely what Löwgren & Stolterman (2004) call the *fully dynamic dialectical process* that develops vision and design concepts. The Probes support this process by providing selectable insights for synthesis and evaluation. The following example shows a dialogue during which the designers refer back to parts of the completed Probes rather selectively to inform their design process. The example comes from workshop H. The design team worked with MWC1's completed Probe.

The design team explored the Probe for a while, and then formulated their first design vision. Their idea was to re-create MWC1's feeling of being in her home office. Designer H4 suggested that making her less dependent on her home office could be a worthwhile route to explore. Designer H3 however challenged this vision immediately. She did so by referring to particular aspects in the presented insights: *"I get the impression, that there are a lot of tangible, physical aspects of the private office that makes it important."* The team confirmed this interpretation by looking at the curated Probe. They found out that she actually depends on local resources in this place. Consequently they dropped the vision and started looking for a new focus.

The design team then looked at MWC1's actual emailing habits. Designer D1 started a discussion about the respondent's handling of email clients. The group discussed this focus and D4 read out one of MWC1's quotes: *"I could not catch up*

with all these things during the day. So I pushed it back to later that day.” Designer D4 added: *“So it seems [...] she has to go back to her private office, after she gets back from work, to take care of things that she could not take care of.”* This particular quote made the group articulate a new design vision. They wanted to design a device that could help the respondent organise and structure her day. The design team agreed on this new design vision.

With this in mind the group’s first attempt was to design ‘something’ that allowed MWC1 to catch up with mails in between places and activities. Again they consulted the Probe, which suggested that she does not want to communicate en-route. Only when designer D4 spoke about his own perception of daytimes and his approach to thinking in segments did the discussion experience a twist and gain new momentum. The design team decided that a map-like email interface could support MWC1 well. The map visualised incoming and outgoing calls and text messages alongside her daily trajectories. Designer H1 proposed this design concept in reference to the Probe itself: *“A little bit like this [note: points at the space-time diary on the hankie]. If she had a better sense of her day and if she knows that she needs to be in three places and do certain actions, she could annotate these actions based on where she is [...]. She could add something here and something there and so on. She receives a phone call here and can point to the place where she can deal with it on the map.”* This articulation of the design concepts behaviour sounded convincing to the group. They decided to take this concept forward and the designers went on to explore it deeper.

This example shows that selectively referring to the Probes content helped to generate and evaluate design visions and concepts. The next section will explore and analyse further influences that have been observed as part of this interleaved design processes working with the curated Hankie Probes.

7.2 Second analysis: Designers’ roles and other Influences on the design process

This section presents the second analysis in this chapter. First, this examined the *designers’ interpretation and experience*, which augmented the presented insights about users and contexts with subjective insights. The analysis also revealed the importance of the designers’ design know-how, which introduced useful references for ‘materialising’ design visions into concrete design concepts. Second, this

section discusses the role of the concept of the space-time diary and its visual design, as well as the respondents' personalities as a source of design inspiration.

7.2.1 Method of Analysis, data sources and process of analysis

The analysis presented here is based on the critical incidents that were identified for the analysis presented in Chapter 6. Furthermore, the data sources⁵⁸ and the process of analysis⁵⁹ are as in Chapter 6. The process involves two levels of analysis and is shown in Figure 7.3. However, the qualitative analysis presented here looked at these already identified incidents from a different perspective. Rather than analysing the influence of the middle range theory of mobile interaction trajectories, this analysis looked for *other* aspects influencing the articulation of design visions and design concepts. As in Chapter 6, the analysis is based on protocol analysis, as often used in design studies (e.g. Cross et al. 1996), and followed the process and terminology of qualitative data analysis as described by Lazar et al. (2010) and Rogers et al. (2004).

The following sections present the results of this analysis.

⁵⁸ The analysis draws from the following data sources: The protocols of workshops A to H. The protocols of design workshops E to H cover the design teams' entire discussions, from first exposure to the Probe to the end of each design workshop. These transcripts are the primary data source. From workshops A to D, I consider the designers' post-design reflection and the designers' sketches and notes. For workshops A to D, the protocols only cover the post-design reflection – this is due to an altered study setup, as explained in *Chapter 4 Methodology*. In workshops A to D, designers worked by themselves and their process is documented with their design outcomes and their post-design reflection only. Hence, for those workshops there are no protocols that describe the designers' full process. Lastly, I consider my own experience in working with the Probes as an additional supportive source of evidence.

⁵⁹ The first level analysis revisited the critical incidents identified in the transcripts of design workshops (see Chapter 6). A critical incident was identified whenever a designer uttered a design vision or design concept. The second level analysis looked at the identified critical incidents. The qualitative analysis of the transcripts revealed thematic categories that were shown to influence and inform the articulation of design vision and design concepts. I then looked for supportive evidence and further influences in the additional data sources (post-design reflection, sketches and notes of workshops A to D; and researchers' notes). The further qualitative analysis identified the role of each of these categories for the articulation of a design vision and design concepts as well as their influence on the design workshops. This revealed how each of these thematic categories informed the design process.

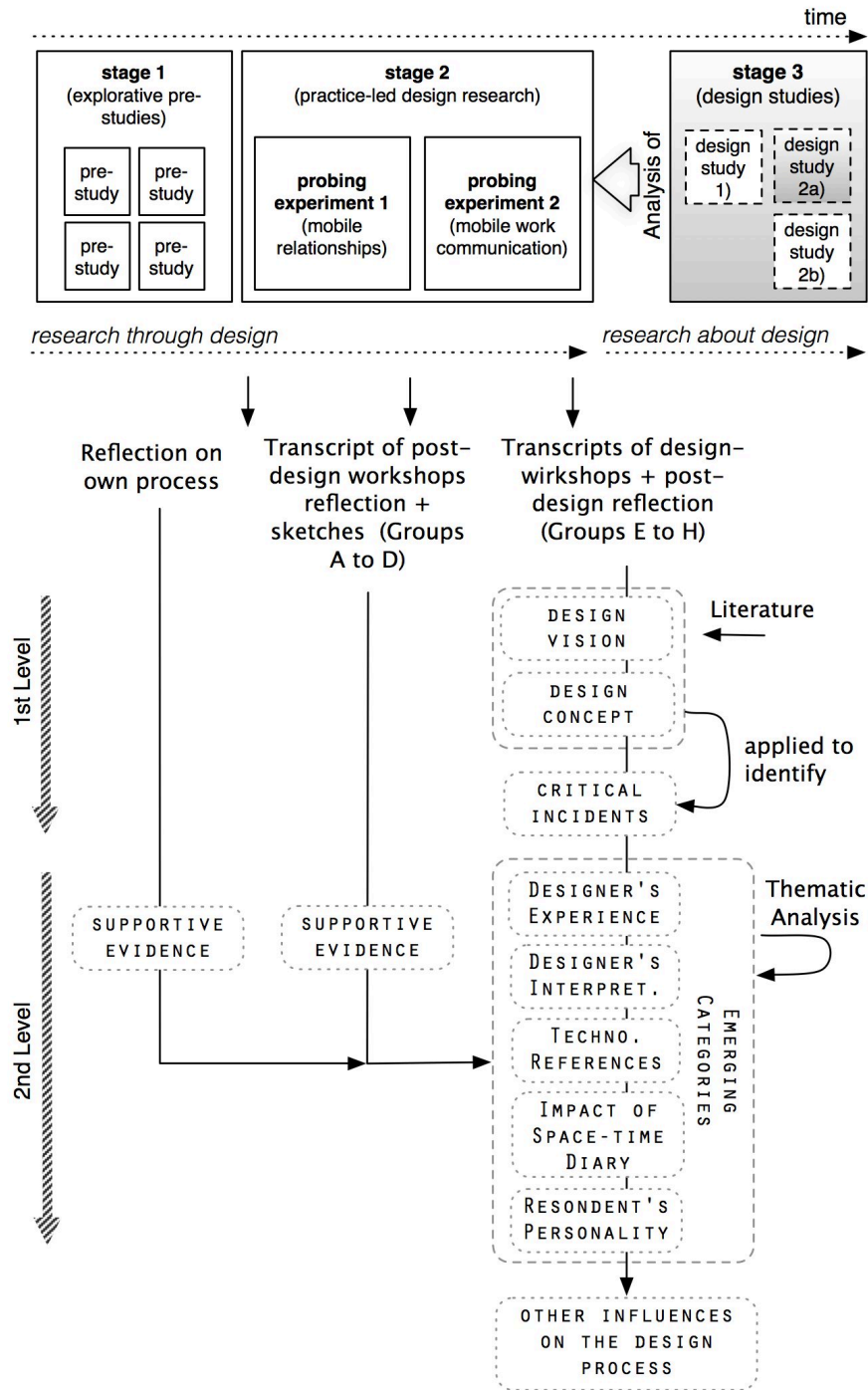


Figure 7.3: The process of analysis of other influences in design sessions A to H

7.2.2 Results: Six categories of other influences

Six additional categories emerged from the thematic analysis: three of these are related to the designers' background: the *designer's experience*, *technological possibilities* and *the designer's interpretation*. Two other categories relate to the design of the Probe: the *space-time diary* as a central entity guiding design teams' exploration, as well as its *concept* (tracking and visualising people's trajectories

over time with an abstract map) and *graphic design* (the abstract map's visual design). The sixth influential category was found to be the *Probe respondent's personality*. Designers could inform their processes by looking at *who* the person was, although the Hankie Probe did not particularly emphasise this aspect.

- *The designer's experience*: The thematic analysis revealed several points in the design process at which designers augmented the presented insights about users and contexts with their own experiences. Designers' statements related to the communicated insights, but introduced new aspects. These additional insights stemmed from the designers' professional or personal experience.
- *The designer's interpretation*: The design teams worked with the curated Hankie Probes and interpreted them through their subjective viewpoints. In doing so, the designer introduced interpretations of what particular aspects of the presented instance of mobile interaction trajectories *could mean*. Statements in this category typically show forms of speculation, such as "*I think what this means...*" or "*So, it seems like...*".
- *Technological possibilities and design skill*: Technological possibilities describe the designers' skills and ability to turn a design vision into a design concept. The knowledge about interactive technologies and "what they can do" acted as a reference and precedence that helped to imagine how a vision could play out on a particular interactive device. For example, a designer suggests what a design vision could look like on the screen of a tablet PC.
- *The space-time diary*: This category summarises comments and notes that refer to the sewn and sketched space-time diaries on the curated Probes. The space-time diary appears as an abstract map, which represents respondents' trajectories and places of mobile connectedness. This map offered a first impression of the presented instance of mobile interaction trajectories and guided the exploration of the insights.
- *The hankie's concept and its graphic design*: This category summarises examples that show designers adopting the space-time diary's concept and/or its graphic design as a reference for their design concepts.
- *The respondent's personality*: This category summarises incidents that show designers using the respondent's personality to inspire and inform their design process.

These six categories will be elaborated over the next sections.

7.2.3. Results: Designer's experience, skill and interpretation

The designer's *subjective experience* and *interpretation* was found to have a impact on the generative design processes. The analysis revealed three relevant findings:

- The designers' experiences *augmented* the presented insights about users and context by adding new (but thematically relevant) insights stemming from the designers' professional or private backgrounds.
- The designers rearticulated (interpreted) parts of the Probe from their point of view. This appeared as an approach to empathise with the presented instance of mobile interaction trajectories and get familiar with particular details of the curated Probe.
- The designers' know-how in designing with and for interactive technologies acted as a design reference to turn design vision into first design concepts.

I now discuss and illustrate these points in a more detailed way and introduce examples from the design workshops.

Designers augment insights about users and context: Designers augmented the presented instances of mobile interaction trajectories. They added examples from their own experiences that related to the curated Probes. These were experiences with communication technologies in private or professional situations. The completed Probes were invitations for designers to bring their 'stuff' to the table, in the form of experiences, precedents, references, etc. The Probes set the thematic frame. Designers augmented these insights about users and contexts with their own subjective experiences, which they used not only to inform the articulation of design visions or design concepts, but also to evaluate ideas and concepts.

The designers' subjective experience was used to a considerable extent in design workshops. There are several incidents showing how the generated design concepts were influenced by this characteristic of the design workshops. In general, the designers' experience played a role for 10 out of 68 articulated design visions, and for 15 out of 63 articulated design concepts. Designers used their subjective experience most extensively when evaluating ideas as part of the short iterative circles (in 39 out of 80 observed statements of evaluation).

The content of designers' input was diverse. They added their own experience of being in certain places, e.g. how one feels at a museum, in a pub, at home or at work. They explained their own experiences managing time and multiple work commitments as well as their own practices in dealing with communication devices (etc.). In these cases, the designers did not only *interpret* an already presented insight, rather they *augmented* the presented instance adding new insights. The following paragraph introduces an example:

As an example in workshop G, the designers discussed design concepts for office environments. G2 started talking about her own office culture: “*Just one example what we have: Earphones! We introduced that concept, because we have an open office. If people have their earphones on, you don't speak to them*”. The other designer (G1) recalled a similar example from one of his past offices too. These insights opened up a route for the design team to discuss different ways in visualising the degree of mediated communication in office environments - in order to visualise virtual busyness to people who are physically close. The designers' background and their experience with similar situations were key to this process. This introduced a new insight that the curated Probe did not depict. The designer's experience augmented the described insights and – in this particular case – also introduced a focus for design. The designer's example (earphones) further acted as a reference in the remainder of the design processes.

Being able to relate to and identify with the insights about users and contexts seemed to be an essential trait of generative design processes. Each designer's closeness or distance to the presented instances of mobile interaction trajectories was an important aspect. For example, the present designers – all working at research institutions – felt better able to relate to respondent MWC2. MWC2 works in a University context too. In contrast, the present designers felt they could relate to MWC3's work practice less. This respondent works in an industry that was alien to all of the present designers. The designers confirmed this impression in their post-design reflections.

Designers' interpretation: The designers' subjective interpretation was a relevant source for the design processes. Probes are uncertain by default and need to be interpreted. Consequently, the curated Hankie Probes required the design teams to interpret the presented instances of mobile interaction trajectories and their details. The designers interpreted the Probe from their own perspective in order to understand what the completed Probe and the depicted instances could mean.

The analysis led to 68 recorded and articulated design visions in workshops E to H. 10 of these 68 incidents showed an explicit form of subjective data interpretation, e.g. statements that included terms like *“It seems that...”, “I think this means that...”*, or similar. Designers stated 63 (ideas for) design concepts. 13 out of these 63 showed a form of subjective interpretation. Lastly, the data shows 80 articulated evaluations. 26 out of these 80 evaluations show a form of subjective interpretation.

The following examples show how discussing and re-interpreting instances of mobile interaction trajectories appears as a way of understanding the presented insights from a personal point of view.

Designer E2 looked at MWC5’s curated Probe and came to the following conclusion: *“I think MWC5 is a person who comes from the 90ies. He wants the real thing. [...] He needs something alive, or something physical.”* Designers’ interpretative statements are characterised by this expression of what the Probe response *could actually mean*. This type of statement suggests how the presented insights can (or need to) be interpreted. The designer interpretation is an approach to re-articulate the presented insights about users and contexts, but from their own perspective. Workshop H introduces another example. The design team looked at MWC2’s habits when dealing with a high number of emails. H1 interpreted what she saw in the presented insights: *“She seems to have moments and places for those communications. I thought this could be the design challenge.”* H3 also saw a similar trait in this Probe detail: *“So it seems [...] her strategy is to a large extent based on place.”* These two example statements show a form of interpretation that is used to argue what a Probe detail means and how it should be interpreted.

Technological possibilities as reference and design skill: The designers’ input included know-how about the design of interactive devices. This know-how occurred in the form of examples of what contemporary interactive technologies are *able to do*, e.g. how GPS works and how a design concept could benefit from this technology. First, designers used existing technologies as references that could be used to address a design vision with an adapted version of this technology. Designers used examples from other projects or design concepts from other design cases as well. Second, technological possibilities were expressed in the form of design skill, namely the designer’s skill to imagine a design vision playing out on a particular information and communication technology. These

influences typically entered the design process *later* in each design workshop. For instance, when a design vision was already in place, but without a clear idea of how the vision can be turned into a design concept. Some examples show this influence.

In workshop F the design team worked on a design concept for MWC2. In particular, they looked into alternative ways for visualising incoming emails. Designer 1F drew from her private solution in dealing with numerous emails. She comments: *“A thing that I implemented [...]: Every email that is not sent to me directly, like from an email list, is slightly pink. I know that they are not important, because they don’t have my address in it. If I only have new pink emails, I can’t be bothered.”* A few minutes later the group combined this concept as a reference in a slightly deviated form to design a tangible device for email visualisation. The trigger was the solution from the designer’s background that she introduced to the design process as a reference.

Designers’ know-how on technological possibilities helped to imagine how a design vision can look like using certain types of technologies. For example, designer D4, who thought about a concept for MWC1 reflected: *“I can see this [note: a design concept] working well on a large format tablet.”* Such technological frames were mostly used to iterate a design concept, e.g. by envisioning how a design could look like on a tablet PC or on a mobile phone screen (etc.). Such contemporary technological possibilities were a reference that gave concrete shape to the gestalt and the functionality of a design concept. The designer’s skills and know-how about ‘what is possible’, and their experience in designing for a particular type of technology, e.g. as an expert for mobile systems design, played a role in ‘materialising’ design visions into design concepts.

Such influences were observed for the articulation of 2 design visions and 14 times in relation to the 63 articulated ideas for design concepts. In addition, 2 evaluation incidents were observed.

7.2.4 The Probe design and the respondents’ personality

I lastly cover three other observed influences on the design processes. First, the space-time diaries’ function to convey a first impression and to guide the exploration. Second, the space-time diary’s graphic design. Third, the Probe respondent’s personality as an informative source for the design processes.

The space-time diary as anchor point: The space-time diary offered a first glance-impression of the respondent's daily trajectory. The visual appearance left designers with a first impression and feel about the instances of mobile interaction trajectories that they were confronted with. The time-space diary was either stitched or drawn, its tangible and handmade nature enhanced the device's prominent role. The particular value of the handmade fabric-based Probes are reported in Chapter 8, discussing how the handmade style influenced the space-time diary's prominent role in the design workshops. This section, however, reports about its concept, namely showing people's everyday trajectories as a visual map.

Several comments and observations hint at the space-time diary's central role. Designer 4H's first reaction to the Probe was: "*My initial reaction is that this map is worth helpful in understanding her routine [...] It seems like she has a lot going on.*" Designer 1E recalls her first reaction to MWC1's space-time diary: "*My first impression was that she visited a number of different places [note: points at the hankie], and she does not really turn-off her communication.*" Designer 1E comments on the space-time diary in a similar way: "*I think it is absolutely good. Especially the use of locations and circles. It is very visual and you get the idea. Otherwise when you read a long interview, this part of the information is lost. You pay more attention to his interest or to this or that, but you forget that he is moving all the time.*"

The space-time diary helped designers to explore the Probe. This turned the space-time diary into a directive device for structuring the insights. The respondents' trajectories were a guide-"line" for making sense of the instance of mobile interaction trajectories. For example, to understand the respondent's trajectories and routines, designer 2A and 3B redrew the space-time diary on their sketching sheet in order to familiarise themselves with the chronology of events. In other design sessions, the space-time diary was used as an anchor point to explore the Probe. Designers in workshop F used the space-time diary to follow each individual day that respondent MWC2 had indicated on the space-time diary. In doing so, designer 1F had her finger on the space-time diary and tracked MWC2's daily trajectories, following the stitches with her finger (see Figure 7.4).

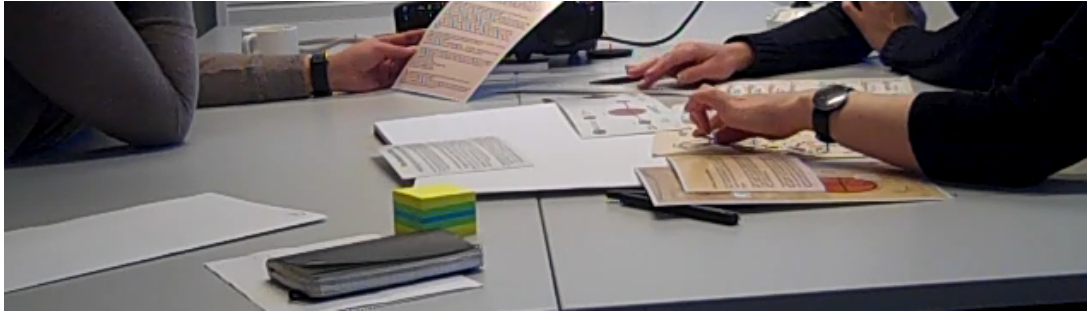


Figure 7.4: Designer 1F tracing stitched paths during the design workshops with her finger. In this session the space-time diary turned into a central artefact that guided the exploration of the curated Probe.

Some drawings and embroidery on the space-time diary appeared more chaotic and abstract, while others appeared more structured and self-explanatory. This aspect influenced how actively the space-time diary was exploited. For some designers, the space-time diary's format was too vague for a quick interpretation, especially when compared to more direct data formats such as written summaries and quotes. Designer 1D reflected: *"The hankie was quite striking but I did not really have a close look. Maybe I would have dealt with this differently, if the other information wasn't quite at a detailed level."* Designer 1A commented: *"I did not really get much out of these [note: points at completed space-time diary]. I don't understand it enough to quickly get a sense. It's colourful and I like looking at them, but I can't read the annotations."* Such comments show that the space-time diary was not supportive for every designer. At times it appeared as too abstract and too hard to read (literally and/or metaphorically). In such cases, the space-time diary and the respondent's notes turned into a device that was nice to look at, but with no further use for the design process.

The space-time diary's concept and its graphic design: The Probe design influenced the design processes in two ways. First, some designers adopted the Probe's conceptual idea of tracking and visualising communication behaviour with a space-time diary. By *concept design*, I refer to the concept of a visual and two-dimensional diary that is used to indicate personal trajectories and places. Second, designers took the space-time diary's visual design as a reference for displaying and managing communication behaviour. With *visual design*, I refer to the circle layout printed onto the hankie. This aspect influenced the articulation of two design concepts. Hence, it was a minor direct influence on design concepts. The following examples explain how designers rethought the space-time diary for a design concept. In other words: the space-time diary became a reference that helped articulating design visions and design concepts. Some designers applied the visual

layout of the space-time diary for their design concept. Other made use of the theoretical approach of capturing and expressing physical mobility and moments/periods of connectedness with a map-like space-time diary. This can also be interpreted in favour of the strength of the theoretical framing of the Hankie Probe, which seemed to be a suitable approach for interpreting and communication of mediated communication in the context of physical mobility.

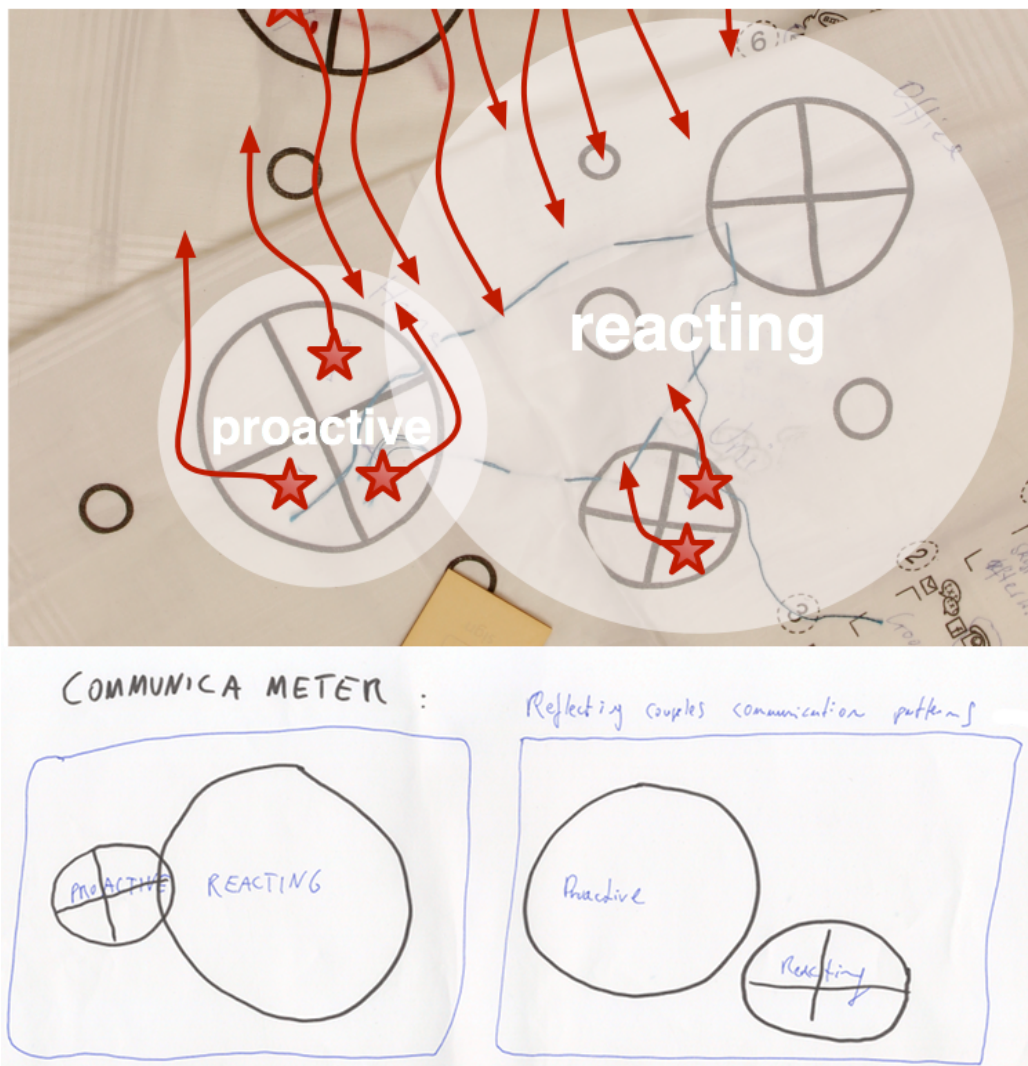


Figure 7.5: Designer 3A took the layout of the space-time diary's annotated version as direct input for a concept for an ambient display. Top: layout of the space-time diary's annotated version. Bottom: concept sketch of the ambient display.

Example 1 (Visual design): Designer 3A worked with couple MRS3's completed Probe, which hinted at the couple's imbalanced communication behaviour. Designer 3A imagined an ambient display that shows the amount of communication instigated by each partner, which could then help the couple recognise this imbalance. The designer's first sketch of this design concept

showed evident influences from the space-time diary's visual design (see Figure 7.5). The designer adopted the visual layout of the presented Probe almost directly.

Example 2 (Concept and visual design): Designer 1H adopted the space-time diary's concept to help organise virtual communication with a visual map. The designer imagined a space-time diary similar to the Hankie Probe, working as a mind-map on the screen of a tablet PC (see Figure 7.6). The software shows frequent places and personal trajectories. Incoming, missed and answered calls (and emails) are displayed and managed on this map. The mind-map allows users to place notes and reminders as well as emails and calls that need to be answered on points alongside the personal trajectory.

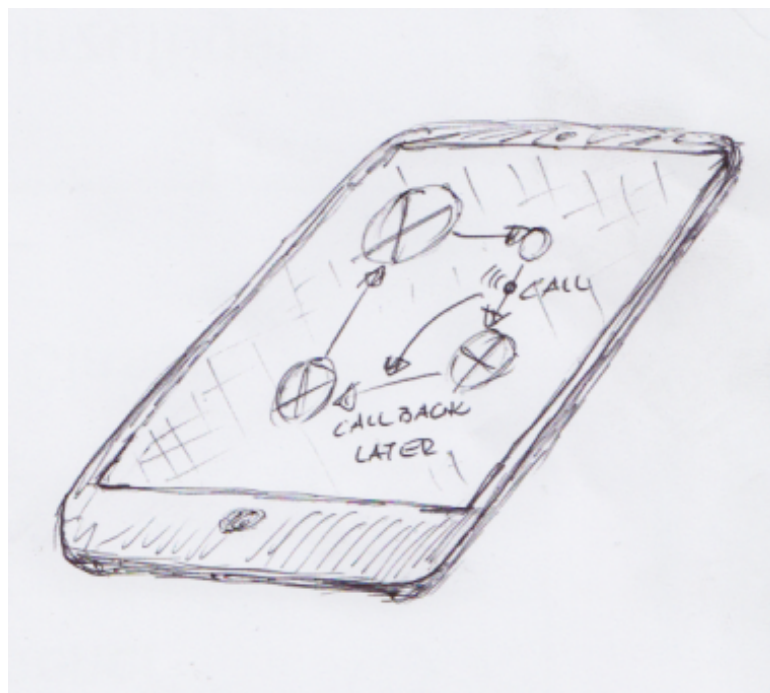


Figure 7.6: Designer 1H suggested to use a space-time diary to visualise the chronology and locality of mediated communication, e.g. incoming emails, phone calls, etc. This can help the user to juggle with communicative commitments in course of a working day.

The Probe respondent's personality: The curated Probes did not prominently and explicitly highlight the Probe respondents' personalities. It implicitly presented respondent's personal characteristics. On occasion, such descriptions had an influence on the design process. Some designers referred to the Probe respondent's personality to argue for a particular design vision or design concept. There were 5 incidents when the Probe respondents' personality influenced design visions, 2 incidents when it influenced the articulation of design concepts and 2 incidents of evaluation. However, it can't be said for certain, which curated Probe

aspect informed the designer’s idea about the respondent’s personality. It was the sum of the insights presented.

The first two of the following examples hint at the general relevance of the respondent’s personality for the design processes. Designer 4A commented: “*For me this was the most useful [note: points at quotes]; because with [these] quotes you get behind the personality.*” Designer 3D described how she explored the data and thereby hinted at the relevance of the respondent’s personality: “*I noted down some keywords, which I wanted to consider: A bit about how old they are and that they are not that technologically advanced.*” Other examples indicate a more direct link between the Probe respondent’s personality and the design process. In this particular example the personality played a role in the articulation of a design vision. Designer 2E concluded that he thought MWC5 was a person coming from the 90s, because he appeared to him as less technology savvy, but instead more interested in ‘natural things’. Designer 2E proposed something ‘tangible and real’ for MWC5. He proposed a design concept for a pet-mounted device.

7.3 Conclusion and Discussion

The analysis presented in this chapter is summarised in Table 7.1.

Findings:	Contribution to Knowledge
<ul style="list-style-type: none"> • The curated Probes were used in iteratively evolving design processes • The curated Probes introduced theoretically and thematically framed instances of mobile interaction trajectories • The instances offered <i>scopes</i> for exploration. Design teams <i>focused</i> on scopes during their design process. • The instances introduced selectable <i>reference</i> points for synthesis and evaluation of design visions and concepts. • In the design setting the instances were completed by designers’ experience, subjective interpretation and design skill. • The Probe design itself and the respondent’s personality influenced design visions and design concepts. 	<p>A new theoretical understanding of probing is proposed:</p> <p>In design settings and during an iteratively evolving design process Probes allow designers’ dialogical interaction with insights about users and contexts, offering a theoretical and thematic frame, scopes to focus on, and selectable reference points for synthesis and evaluation of design visions and design concepts.</p>

Table 7.1: Chapter 7’s findings showing the characteristics of and the influence on the design process with the curated Hankie Probes.

The findings presented in this chapter show that the instances of mobile interaction trajectories presented via curated Probes provided thematic and theoretically

framed insights for the design processes. The presented instances suggested a number of scopes for exploration. Some of these emphasised trajectories and places of mediated communication. Others highlighted interaction chronologies, practices and experiences of device communication routines. Rather than staying on a holistic level taking every aspect into account, designers eventually focused on one of these scopes during their process. Therefore, the value of mobile interaction trajectories as a design theory lies in its potential to identify a variety of potential scopes without favouring one over the other. Design teams did not design for the entire instance of mobile interaction trajectories, but for an excerpt, a particular place or experience, etc.

Findings in this chapter show that insights stemming from mobile interaction trajectories were combined with a variety of inspirational influences stemming from the design setting. The generative design processes relied on a range of insights augmenting and enriching the instances of mobile interaction trajectories. For example, designers drew from their own experiences. Their design skills and know-how on interactive technologies shaped the design concepts. This reinforces the conclusion that mobile interaction trajectories set the scene, provided a range of scopes directing and insights informing the design process, but were enriched by influences coming from the design setting. The middle range theory of mobile interaction trajectories introduces a foundation that is completed by designers.

The space-time diary appeared to be a central device featuring physical movement prominently. Working with visual space-time diaries drew designers towards this aspect of the curated Probes. This (partly) explains the high number of design visions and design ideas stemming from and addressing respondent's physical movement patterns, as discussed in Chapter 6. Chapter 8 will show that the fabric-based format enhanced this aspect even further. Hence, the decision to collect and express mobile interaction trajectories via handmade space-time diaries reinforced the focus on design concepts related to people's everyday trajectories. The results presented in Chapter 6 are therefore strongly linked to this particular Probe design.

These findings extend understandings of the nature of probing interpreted as a design approach.

The current state-of-the-art literature highlights the value of Probes for insights-collection. From this perspective, probing leads to a set of completed Probes that

represent a user or a context. According to this view, probing's result is a set of completed and static Probes and a collection of insights, which can inspire designers and humanise respondents. A more profound understanding of the Probe's role in the design process is missing. The design process with Probes has been rather poorly understood and perceived as *black art* (Boehner et al., 2007).

In response to this state-of-the art, findings in this chapter allow a more direct interpretation of probing as a design approach. The chapter presented a more explicit picture of the Probes' role as part of the design process, which suggests that the approach's value is found in the continuous reorganisation and reflection upon the presented insights about users and contexts – as part of an iteratively evolving design process. The generative value of probing lies in a *continuously adapted focus* on the presented insights about users and context. The completed Probes suggest a number of scopes and provide a diverse range of particular details (quotes, sketches, the design of the Probe itself etc.). These act as a selectable reference points for synthesis and evaluation during the course of the ideation process. This is the baseline for understanding probing as a design approach, rather than a pure design research approach emphasising insights-collection only. The Probes' three functions in the design process have been identified and discussed, but will be repeated here because they corroborate and refine Gaver et al.'s (2004) arguments for *the value of uncertainty* as a value for generative design process.

First, the curated Probes provided an instance to designers that suggested a thematic frame to work in. The instances of mobile interaction trajectories are a result of the Probes' theoretical framing. First of all, this finding relates to Gaver et al.'s (2004) argument for Probes to thwart the researcher's/designer's idea of users and contexts. Since the Probe is designed based upon the theoretical understanding of users and contexts, the completed and curated Probes can only challenge the designer's/researcher's theoretical idea about users and contexts up to a certain extent. The completed and curated Probes can however help to elaborate this theoretical notion further. They can introduce examples that make the researcher interpret their theoretical perspective on users and contexts from new and so far unconsidered angles. Uncertain responses therefore alter and extend this initial theoretical perspective of users and contexts that the design process starts with. This corroborates Gaver et al.'s (2004) core argument for the value of uncertainty.

Second, the Hankie Probes offered different scopes for a deeper design exploration. This finding is not entirely new, but confirms existing results. Lucero et al. (2007) report that completed Probes pointed to a range of scopes, some of which suggest new and unappreciated perspectives. The analysis in this chapter extends this finding and shows how design teams discover, manage and negotiate several scopes over the course of the design process. These scopes that Lucero et al. speak about are not immediately evident for designers per se, but are discovered and evaluated during design processes. Further, this characteristic affects the designer's divergence over the course of their process, which is an essential and valuable part of design process. *Divergence* means that designers explore several potential scopes before focusing on one for a deeper exploration. At this point, uncertainty can enhance the design process in two ways, both of which address divergence as a typical characteristic of the design process. The Probes present a mix of anticipated and unanticipated scopes for designers to focus on. Hence, the Probe introduces a number of scopes the researchers/designers would not have explored and focused on otherwise. The basis for divergence is broadened. The value of uncertainty however also surfaces when designers explore the range of suggested scopes: The completed Probes do not suggest a hierarchy of scopes. The design team is required to assess the value of each potential focus as they go through their process. Looking for design opportunities more broadly, instead of focusing on one single scope can enrich the generative design process.

Third, particular details of the completed and curated Probes are used as selectable reference points to synthesise and evaluate design concepts during the design process. This finding supports existing research literature that describes design as benefitting from particular details (Mattelmäki, 2006), as well as from rich and representative insights about activities, experiences and routines (Lucero et al. 2007). This research goes one step further and reveals the Probe's low-level details as intrinsic Probe elements that keep the iterative design process running. These selectable reference points are essential for the core process of consecutive synthesis and evaluation. If these selectable elements had a certain meaning, they could be selected and used less flexibly during this process. Elements with an uncertain meaning can be selected in order to argue for or against a design concept with greater freedom. The meaning of each single element arises from the current focus on the presented insights about users and context. Thus, Probes' uncertainty can aid generative process, not only by altering the initial theoretical

perspective on users and context, but also affects the design process's core characteristic.

This chapter also identified the Probe design's roles within the design process. User and context focused design resources in the design setting, like the space-time diary and its graphic design, had an influence on the design work. This shows that the Probe design does not only provide rich visual narratives to present the insights about users and contexts in a multi-dimensional way (Visser, 2011), but that it can inspire the look and feel of design concepts too. Further, the design process with Probes allows the integration of designers' background and their design expertise. This influence has not been emphasised in the Probing literature so far. According to the findings presented in this chapter this influence is key for the approach's generative value to emerge. The analysis suggests that the value of probing reveals its full potential only when the completed or curated Probes are contextualised to particular design settings. In this setting the process is prone to picking up contextual insights, like the design of the Probe or the designer's experience. This 'openness to the design setting' was revealed as a relevant aspect for the articulation of design visions and design concepts. Hence, the completed Probes are only *fully complete* once designers deal with it in particular design settings.

Similarities with sketching: The dialogical interaction between completed Probes and designer shows similarities with *design sketching*. Comparing the work with Probes with design practices like sketching, instead of opposing it with methodologies like ethnography, can help in understanding the approach's value better. The aim of this short reflection is to argue for a paradigm shift towards discussing *probing* as a literal design approach (rather than an approach for insights collection). It is not the aim to compare sketching with probing at a detailed level, which would require a different study setup.

This is not to say that probing functions in a similar way as design drawing. They perform quite different roles. However, the dialogical value of design drawing, which is seen as an elaboration of the designer's thinking about the design context, may help to understand the value of probing better. Drawing is seen as a tool of exploration and as a way to structure a design context and elaborate potential design concepts Lawson (2004, 2005). Lawson (2004) summarises design drawing *as windows into the designer's mind*, which reveals the current thinking and focus

of the design inquiry. Drawing is described as an on-going process of exploration that opens up problem and solution spaces in the course of a design process. It also allows designer to block some details out and concentrate and elaborate further upon one aspect of the design concept. The analysis in this chapter has shown the design processes with Probes to have similar basic structures, albeit in a different way.

The findings indicated Probes supports design teams to focus on particular insights about users and contexts over the course of a design process, including and excluding insights dynamically - similar to sketching. They did so by focusing and exploring particular scopes that a Probe suggested and by articulating design visions and design concepts. The design team's changing focus on insights shows their current thinking and direction. When drawing, designers work on their vision and concepts by designing the design concept itself, for example with a sketch. With Probes, designers explore potential solution spaces by focusing on particular scopes, but without directly manipulating and iterating a design concept. In this respect drawing is quite different from probing. Nevertheless there seem to be structural similarities in how drawing and probing contribute to the design process, namely in how they help designers dialogically interact with the design context and insights about users and context.

The remaining Chapter 8 will discuss the fabric-based Probe format's influence on the design teams' processes.

Chapter 8: The value of the Probes' fabric-based handmade format

This chapter presents the Probe design's value, with a particular focus on the fabric format that was used to collect and communicate insights. This chapter aligns with the thesis' secondary research strand: *The value of fabric-based handmade Probes in design workshops*. The main focus of this analysis is to understand the fabric-based handmade Probes' role in design workshops. It is the aim of this chapter to discuss how the designers perceived the completed Probe's core artefact, namely the fabric cloth, and in particular the stitched (drawn and sketched) space-time diaries – referred to below as *handmade space-time diaries*⁶⁰. Insights from this chapter expose how the Probes' fabric format, and in particular its handmade elements⁶¹, influenced the design processes with mobile interaction trajectories⁶².

The next section will introduce the method of analysis, which differs from the method used for the analysis reported in Chapters 6 and 7.

8.1 Method of data analysis

The analysis in this chapter is a mixed-method qualitative approach and followed the process and terminology as described by Lazar et al. (2010) and Rogers et al. (2011). The approach can best be described as *qualitative content analysis*, as it draws from a range of contents types (from text to artefacts), and aims to establish a system of categories that allows describing designers' perception of the fabric-based Probe elements. Drawing from text (interviews, quotes), video (from design workshops) and artefacts (the Hankie Probes), critical incidents were identified for analysis in a range of data sources, which were then reviewed to identify

⁶⁰ As described in Chapter 1, the Probes' fabric-based format is understood as allowing Probe respondents to create individual handmade artefacts. I call the completed Hankie Probes *handmade* as their completion includes craft materials and practices: fabric, embroidery, sewing, stitching and drawing. The Probes' fabric format is understood as an enabler for such practices. A Probe that has been completed using such practices is understood as a *handmade* Probe.

⁶¹ This refers to the Probe's space-time diary that Probe respondents completed by hand, using manipulation techniques, such as stitching, doodling or sketching.

⁶² This particular media and format was expected to enhance the ambiguity of completed Probes. It was hoped it would allow different perspectives for contemplation and analysis. Other Probe parts also had ambiguous elements too, like respondents' quotes and contextual notes. However, most of these Probe elements played an explanatory role, rather than introducing even more ambiguity and subjectivity.

categories of themes that describe designers' perception of the Probes' fabric-based handmade format. Those critical incidents differ from those identified for the analysis reported in Chapters 6 and 7. The particularities of the analysis process and the emerging categories are now described.

8.1.1 Data sources

The analysis draws from the transcripts of design workshops and from the post-design reflection of design workshops A to H. I partly draw from my reflections about the design workshops in my research diary. Additional supporting evidence comes from respondents' reactions during Probe collection; e.g. in interviews with Probe respondents. I identified critical incidents in all these data sources. A critical incident was identified when a designer referred to the fabric format of the Probe, the stitched or embroidered 'artwork' on the space-time diary or to the particularities of its manipulation. This included use of needles and threads, but partly also included respondents' drawings and sketches on the fabric. I also considered statements and comments that refer to designers' perception of the completed handmade space-time diary as a creative and expressive piece. Overall this led to a different set of critical incidents compared to Chapters 6 and 7. I considered the content of each critical incident for further analysis.

8.1.2 Process of analysis

The data sources were first openly coded into categories. A second and selective coding process refined these categories and established the first connection between categories. At this second level, categories were finalised, which also meant merging and renaming categories. Once the final set of categories was established I looked for supporting evidence from other data sources, e.g. my own reflections in the research diary or in respondents' reactions during interviews with Probe respondents.

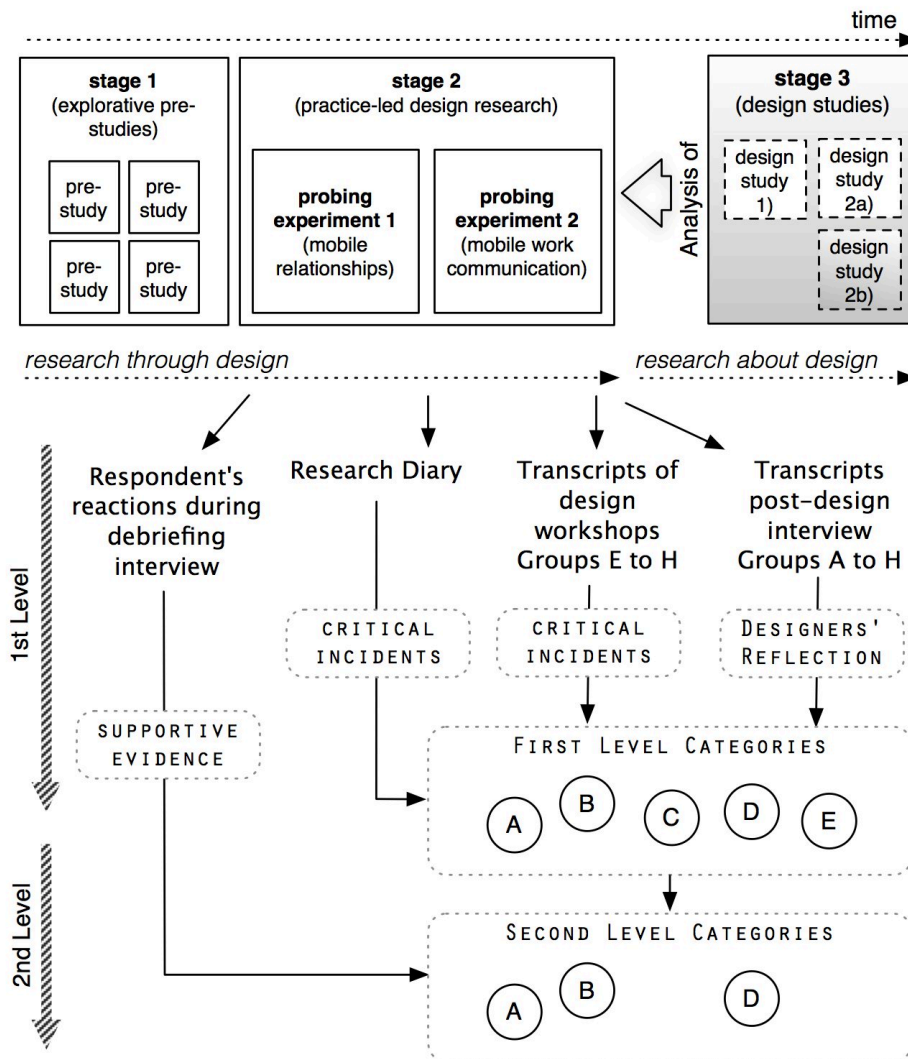


Figure 8.1: A two level process of data analysis. From top to bottom: Data sources emerging out of different project phases (Insights collection via Probes, Probes' curation and design workshops). Critical incidents were selected. The contents of these critical incidents were used for first and second level coding.

8.2 Results: The value of fabric-based handmade Probes in design workshops

The results show three main categories of influences that emerged from analysis. The following scheme describes the sub-categories that emerged from the coding process. Each category represents a number of statements in the data. A few statements were coded into more than one category, e.g. a particular quote that supported two of the emerging categories. Appendix 8.1 documents the record of analysis, including the resulting categories.

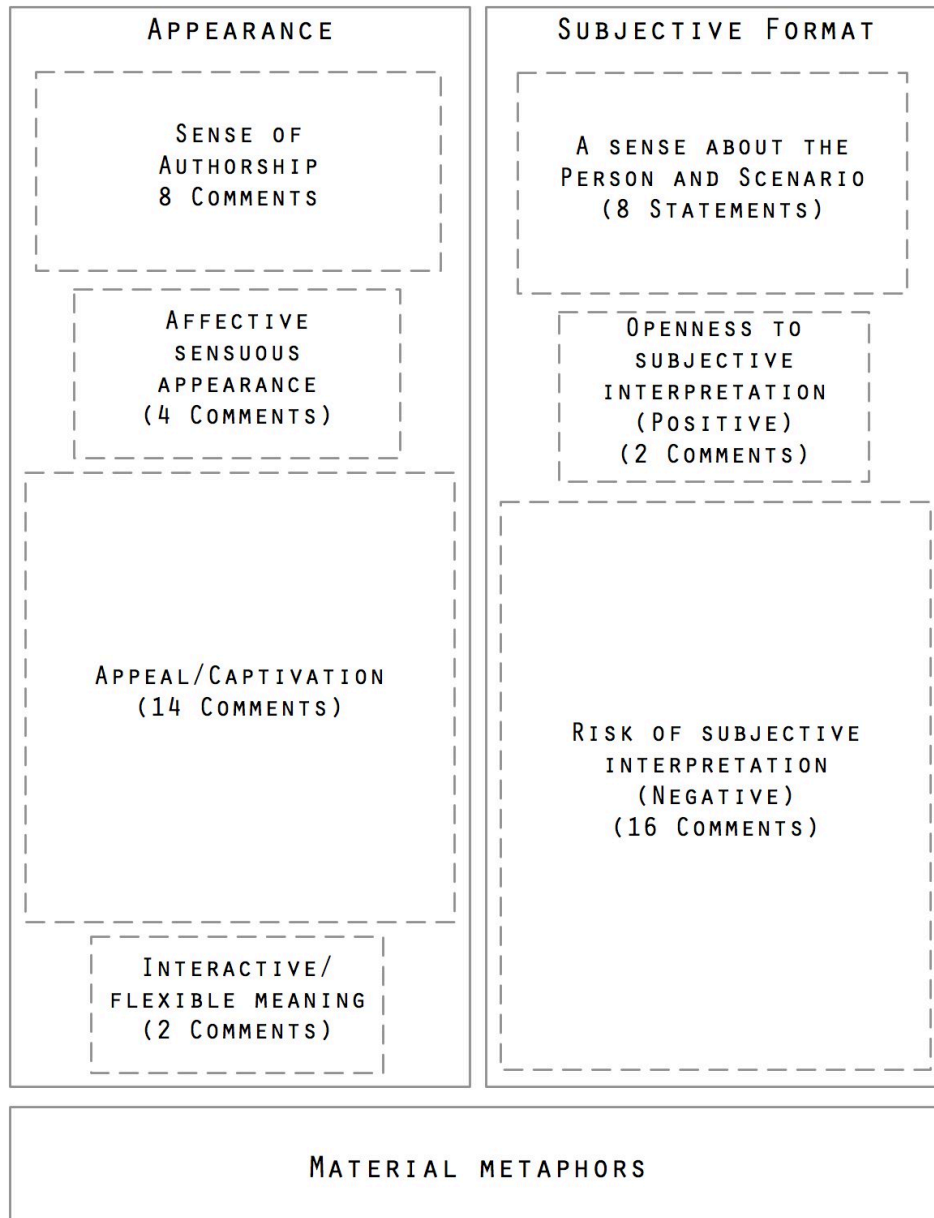


Figure 8.2: The analysis of the design workshops and post-design reflections resulted in three main categories. One (left) explains how the Probe's format appeared. The other main category (right) indicates how designers thought about the need for subjective interpretation of the handmade space-time diaries. The third category (bottom) refers to material metaphors guiding the selection of themes during the Probes' curation processes.

Appearance: The first main category spans four sub-categories, which all refer to the fabric format that enables each completed space-time diary's distinctive appearance. The sub-categories demonstrate that the fabric format contributed to making the space-time diary look 'interesting', distinguishing it from other forms of insight presentation, e.g. written formats.

- *Authorship*: In this category, statements and utterances refer to the handmade space-time diaries appearing as personal objects that represent the artefacts' author. Comments in this category also refer to the fabric-based space-time diaries being perceived as 'real'.
- *Affective sensuous appearance*: This category summarises statements and responses that refer to the fabric-based space-time diaries appearing as an *affective insight* that is physical, that can be touched and manipulated, as opposed to insights that can only be read, e.g. a text-based document
- *Appeal/captivation*: This category summarises responses and statements that describe and refer to the handmade space-time diaries' appealing appearance, which is interesting to look at and to work with due to its materiality or originality. This category also refers to comments that describe the handmade space-time diaries as an attention-catcher.
- *More interactive/'flexible' data and meaning*: This category summarises comments that describe the space-time diaries' fabric format as one that can be flexibly interpreted, because it can be physically manipulated (squeezing, scrunching, etc.)

Subjective aspects: The second main category refers to statements and comments about the space-time diaries needing subjective interpretation. Designers responded to the respondents' individual styles that are visible on the completed handmade space-time diaries. Sub-categories were:

- *A sense about the person and instance of mobile interaction trajectories*: This category summarises statements that indicate that designers read into the handmade style in order to interpret who the person behind the artefact is and to interpret the described instance of mobile interaction trajectories.
- *Openness to subjective interpretation (positive)*: This category summarises statements that describe the need for subjective interpretation positively.
- *Risk of subjective interpretation (negative)*: This category summarises negative statements about the handmade space-time diaries. They describe the artwork as too vague and requiring a degree of interpretation that is too extensive.

Material metaphors: The third main category (bottom of Figure 8.2) summarises critical incidents during the *Probe curation* process. As discussed in Chapter 4, I

pre-analysed each completed Probe, turning it into a curated Probe for presenting an instance of mobile interaction trajectories. In this process, the handmade space-time diaries influenced the selection of themes for instances of mobile interaction trajectories. I was inclined to adapt narratives to match space-time diaries' handmade expressive details. I call them *material metaphors* as these are expressive details in the handmade parts of the space-time diary that represent the *central message* of an instance of mobile interaction trajectories well.

The following sub-sections examine these findings and the three main themes in more detail.

8.2.1 First category: Appearance

The first main category summarises statements that explain how designers perceive the handmade space-time diaries.

8.2.1.1 Authorship

The individual handmade styles with which respondents completed their space-time diaries created a sense of authorship. The handmade style turned the completed space-time diary into a personal artefact. Eight comments document this perception. These comments show that designers saw personal traits through the individual effort put in by the Probe respondents when making their space-time diary. This is a result of the space-time diary being handmade with needles and threads. The handwritten notes, drawings and doodles further reinforced this perception. Using these techniques, the Probe participants left personal traces on the space-time diaries. The designers perceived these traces as *personal marks* that said something about the Probe respondent. The following quotes indicate how some designers saw the handmade space-time diaries: "*I believe the hankies are something 'tangible', something personal. One can see the real person behind; sometimes you can't read the writing cause someone has done this while walking around. I find that cool.*" (Designer 1B). The next quote also hints at this perception: "*I found the hankies quite cool, because it has something very personal and I found this super.*" (B3). Also Designer 1G comments in a similar direction: "*I think it's a balanced thing [note: between several data sources], but you get closer to the individuals through this [note: the space-time diary] because they created this themselves. That is very important.*" (1G). Designer E3 comments: "*It's somehow a subconscious feeling that the person is here.*" B1 also refers to the

space-time diaries' appearance as authentic. She comments: "*You can spread these out and you have the real data.*" The space-time diary is perceived as an original artefact and represents the 'real data'. This was the case, because the artefact showed personal and individual traces. Almost like a person's emblem.

8.3.1.2 An affective sensuous format that can be felt

Four statements relate to the *sensual value* of the Hankie Probes' fabric elements. This characteristic distinguished the completed handmade space-time diaries from the other data formats that were presented, e.g. quotes and summaries as written text. The following statement represents this trait well: "*Here are her own words and this is 'their own bodies', in a way [note: points at the hankie]*". ME: "*This is what?*" HER: "*'Bodies!' Because they did this!*" (2G). Designers tended to talk about feelings and sentiments when they referred to the handmade space-time diary, which they distinguished from more cognitive forms of understanding, like the following comment suggests: "*It is not a document that is sent to you and you read it, a .pdf or similar. This [note: points at the handmade space-time diary] is something that you feel and she did it and we have it here. We 'read' her story.*" (1E). These comments show the artefacts appeared as something that *can be felt* or that represents the *respondent's body*. The handmade space-time diaries allowed sensual ways of empathising, compared to cognitive ways of understanding⁶³.

8.3.1.3 An appealing captivating material format

The analysis revealed the Hankie Probe's appeal. The fabric format and the handmade space-time diary gave the Probe a novel captivating style, which was interesting to look at. The artefact caught designers' attentions. There were 14 comments coded in this category, which makes this characteristic the most prominent one. While being interesting, however, the space-time diaries were considered to be too abstract for some designers. This will be discussed in the next sub-section.

⁶³ This insight shares a characteristic with currently emerging subjective formats of ethnography, e.g. sensory ethnography (<http://sel.fas.harvard.edu/>). These new approaches in social science do not merely target providing a cognitive, objective and aloof picture of a phenomenon. Rather they aim at creating an emotional and sensual understanding of a situation that goes beyond cognitive comprehension and facts. Similarly, approaches like the Sensual Evaluation Instrument (Isbister et al., 2007) add to sensual approaches to design and evaluation in HCI research and interaction design.

The fabric format and the handmade style can sensitise and intrigue designers. The Probe, and especially the space-time diary, was experienced as appealing to look at but also to play around with. Designers expressed that they “*liked looking at it*” and found it “*fascinating*” (designer 1A). A quote from post-interviews with designers summarise this well: Designer H1: “*I think this is really rich, there is a lot in here, this [note: the space-time diary] is something you like.*” Beyond this appeal the handmade space-time diaries invited designers to examine the Probe. This can be interpreted as a quality that prompted the designers to explore the curated Probes, independently from whether designers retrieved something from the handmade artefact for their design or not. Designer E3 explains her initial interest in the artefact that guided her Probe exploration: “*You see a thread and you go ‘this is interesting’ and then you go back to the text to see what is happening, but this [note: the space-time diary] is the trigger. Then you can go back to what he has said exactly.*” The use of fabric, needles and threads for a Probe design was new to designers and some of the attention the handmade space-time diaries caught can also be ascribed to the novelty of the approach itself. In this sense, the use of novel Probe format might be transient. The interest in the artefact would probably drop after a number of exposures. During first contact the fabric format, however, showed these attention-catching *inviting* characteristics.

8.2.1.4 Interactive/‘flexible’ data and meaning

A small number of comments refer to the handmade space-time diaries as a *flexible* medium that can be manipulated and played with. Designers appreciated the Probe’s fabric nature which can be crumpled and crinkle during exploration. This characteristic played a minor role during the design processes. Designer E3 commented: “*If we converted all these things into paper, it would be somehow compressing everything into the 2D space. This [note: the space-time diary] is more interactive and you can get more insights from it.*” This interactive characteristic of the Probe’s format is closely related to its invitation for subjective interpretation. Designer 2E reflected on the format’s flexibility and interpreted this aspect positively: “*This is a more interactive thing. It’s not two-dimensional [...] Right now it’s straightforward [note: plays with the hankie], but right now it’s not anymore. It can be manipulated and now it means something different*” (see Figure 8.5). For some designers, being able to play with and manipulate the artefact introduced an additional level of interpretative freedom. The fabric-based space-time diaries appeared as flexible and interactive in those few cases.



Figure 8.3: Designers 2E shows how the hankie can be manipulated physically. By bending the space-time diary the perception of what a stitched path may mean changes. It is a re-interpretation of an aspect shown on the space-time diary based on the material's flexibility

8.2.2 Second category: Subjective data

The handmade space-time diaries were perceived as a subjective carrier of insights. The individual and handmade styles were central to this subjective appearance, which led to interpretations of the respondents' personality and the instance of mobile interaction trajectories. However, the space-time diary's subjective nature also led to problems of interpretation, mainly introduced by uncertainty about how to interpret the respondents' completed space-time diary. The handmade space-time diaries' format created an object that needed to be deciphered.

8.3.2.1 A sense of the person and the instance of mobile interaction trajectories

Interpreting the maker's personality: The handmade space-time diaries led to assumptions about their makers. Designer 2E explained his perception of the space-time diaries in the following way: *"I get the concept, I get the idea about that person, when I see this. You get the idea who he is or how he does things. How he sews, the drawing and the text, his handwriting. How he used the hankie space. Did he make it dirty, or does it look like brand-new?"* This interpretation is a result of the individual ways in which respondents used the space-time diaries. Designer 3F reflected: *"That is her way of showing what her day looks like. I am getting a sense of how this person thinks about her life."* Designer H3 also commented on this aspect. *"When I look at this it gives me a lot of information. Who is behind that? She is taking the time to draw this, showing some artistic interest, trying to represent this in a personal way."* However, designer H3 also commented on the additional semantic level for interpretation. *"The threshold [note: the level of subjective interpretation] here with the threads and the stitching is so much higher."* With this comment the designer referred to the additional difficulties of interpretation, due to the space-time diaries' fabric format and handmade style.

Although the designer felt seeing 'the person behind the Probe', she raised the issue of over-interpretation. Other designers seemed to be concerned with this aspect too. These concerns about the high degree of subjectivity will be discussed later in this section and was also referred to in *Chapter 7.2.4 The Probe design and the respondents' personality*.

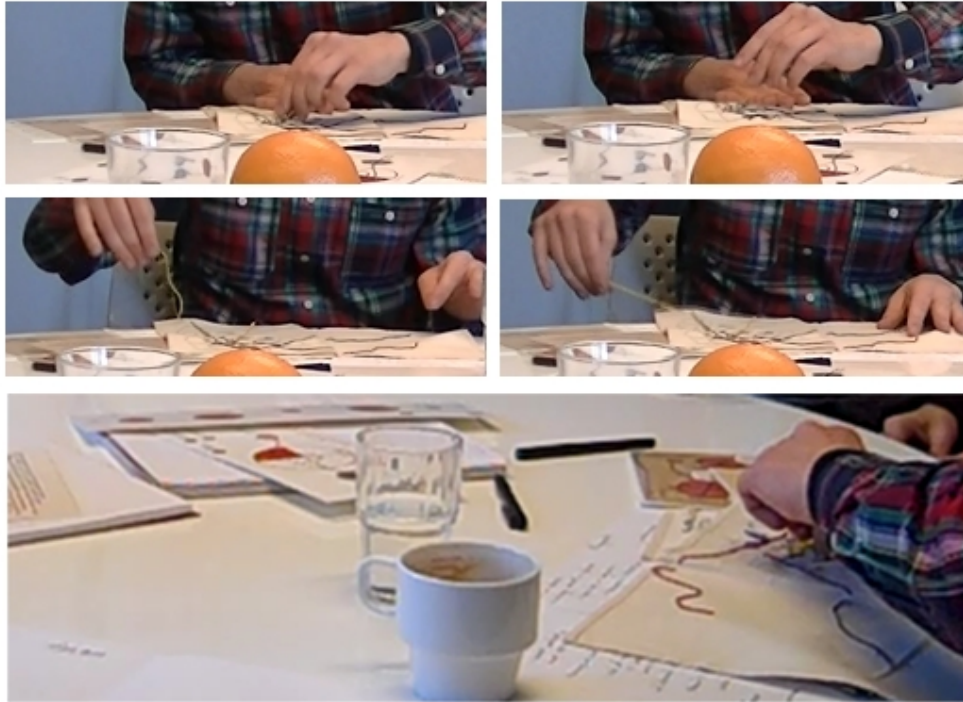


Figure 8.4: Designer 4H explores the making, the handmade style visible on the hankie. The group derived some understanding of who the person is by investigating the effort and style visible in the stitching on the space-time diaries.

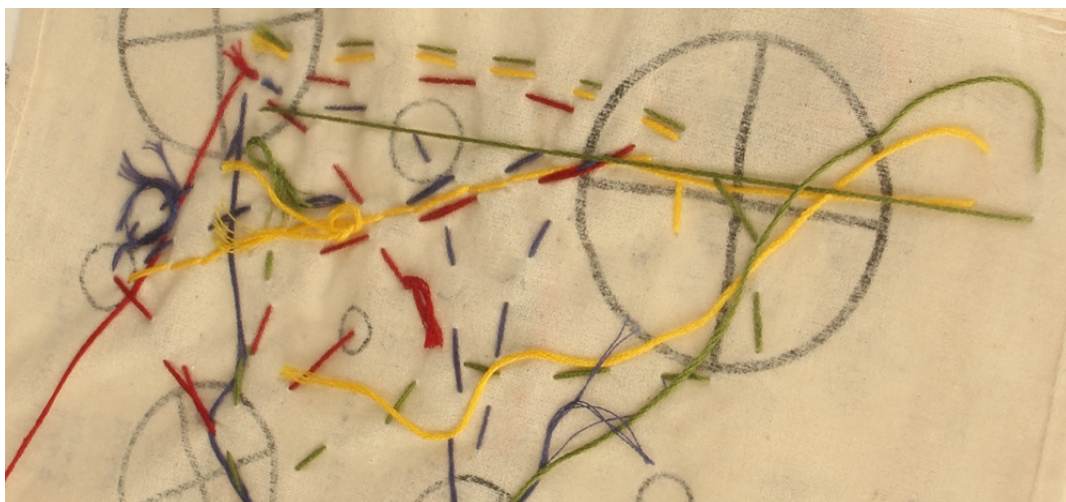


Figure 8.5: The backside of the hankie revealed insights into the maker's style (MWC2's space-time diary, design team H).

As well as introducing an overall personal picture, the designers also retrieved insights from the detailed handmade space-time diaries. They drew from small personal traces that the respondents left on the artefact. Group H decided to look at the handmade details (see Figure 8.4 and 8.5). H4 contemplated the space-time diary and stated: *“Her style: [...]. She was not detailed enough to cut off the loose ends. She did not finish the stitches.”* 2H interjected: *“But then turn it over and see how she weaves the threads back in!”* H3 replied: *“She is making a legend [...]. From a sewing perspective there is something wired going on. I think it’s kind of neat. I like it!”* 4H changed his mind and concluded, *“It’s a good touch!”* This conversation shows how the group developed a sense of who the person was by interpreting how the Probe’s respondent had dealt with and manipulated the artefact when completing it. They started off judging her as having worked a bit ‘sloppily’, but then concluded that she was quite smart by adding the legend to explain her paths.

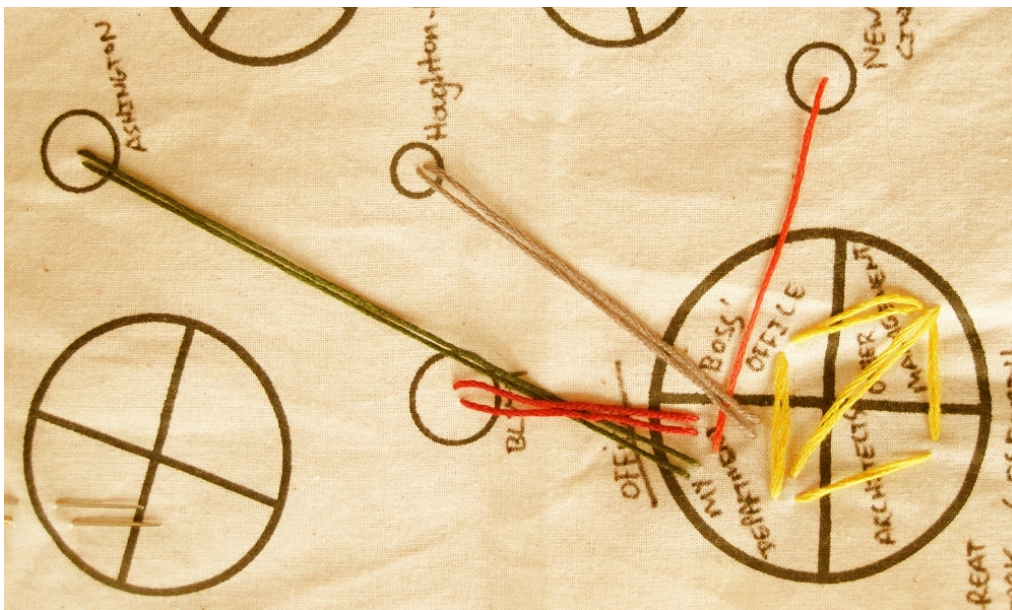


Figure 8.6: The stitching style. In this particular case designers interpreted the straight thread from one place (circle) to the other.

Interpreting the instance of mobile interaction trajectories: The handmade space-time diary on the hankie triggered reflections about the presented instances. This led to assumptions about how an instance of mobile interaction trajectories can be interpreted. There were a few examples that showed how the handmade artefact influenced the perception of the “story” that the probing respondent expressed. For example, designer 1B mentioned that she could feel the rhythm of everyday life looking at the drawn and stitched space-time diary. Designer 1E

reflected on the first impression a particular stitched path left in her mind (see Figure 8.6): “*The first impression was that this person has long drives, [...] and this other place is very tense.*” The first part of the comment refers to long stitches on the space-time diary. The second part refers to the stitched trapeze in the respondent’s ‘work circle’. This sign made the respondent’s office appear as tense to the designer. To understand the presented instance of mobile interaction trajectories, the designer interpreted the respondent’s stitching style. In fact, in the debriefing interview this respondent had explained this trapeze to describe a tense place in terms of mediated and face-to-face communication. Although this quote was not mentioned to the design teams, the designer got this sense. A similar interpretation was observed in workshop F, where long stitches gave the designers a sense of pace in which the instance of mobile interaction trajectories unfolded (See Figure 8.7).

Excerpt - visible effort and care: The designers' impression of getting a sense of the maker and this matched the Probe respondents' perception of dealing with the space-time diaries. Some Probe respondents spoke about their effort and care as well when reflecting about their Probe use.

When asked how she dealt with the space-time diary, respondent MR4a remembered that she sat down to tidy up the space-time diary before the interview. She said: “*I can’t give you anything messy*”. She felt the need to return a tidy looking result. MRS2b commented on his initial ambition to come up with good looking stitching. He laughed and said that he would lack the skills for doing so, but he recalled the feeling of wanting to keep the space-time diary clean and wanting to nurture it. He kept the hankie in its original folded shape as long as he could. Most Probe respondents seemed to deal with the fabric and the space-time diary with effort and care. It seems that the care that Probe respondents had invested (some more, and some less) was visible in the completed space-time diaries. This effort and care shone through and was visible to designers. Appendix 5.1 provides additional reflections on respondents’ use of the fabric-based Probe format for insights collection.



Figure 8.7: The paths that are expressed with rather long stitches were interpreted and perceived as “fast”. Designers commented on the visual and sensual appearance that would give them a sense of pace in which the instance of mobile interaction trajectories unfolds

8.2.2.2 Positive and negative sides of subjectivity

A minority of comments refer to the subjectivity and flexibility of interpretation in a positive sense. Designer E2 commented: *“This is like sketching. Anybody can interpret it in a different way. This is what I like.”* In contrast to such positive comments, a considerable number of comments referred sceptically to the degree of subjective interpretation required. This is partly the result of equivocal space-time diaries that respondents came up with. At least some of the completed space-time diaries had a chaotic first glance appearance. Some space-time diaries were difficult to interpret without additional sources of information. Designer E1 referred to this aspect in one of her comments: *“I look at it and try to find some more information from the text-based data.”* While designers did find irreplaceable value in the space-time diary, they definitely perceived it as an artefact that is hard to understand without additional insights. It was this uncertainty of possible interpretations that made several designers comment negatively. Designer F3 calls this extra effort and uncertainty an *“additional layer”* of interpretation that has to be managed. She remarks: *“There is a whole extra layer for us to understand. What were they saying and what do they really want to tell us? Maybe drawing this [note: the space-time diary] was a problem. The guy wanted to express a sort of problem, but we did not see it at all.”* There were 15 similar comments. This suggests that the Hankie Probe’s fabric format, in particular the handmade space-time diary’s appearance, is perceived as too abstract.

Those comments are not an absolute rejection of the approach. However, they indicate that the handmade space-time diary as a stand-alone device could be

unmanageable for generative design work. Completed Hankie Probes cannot be introduced without additional curation. Further, these comments suggest that this probing format requires time for interpretation. The insights are not directly presented and uncertain in nature, and reveal themselves only through deeper interaction.

8.2.3 Third category: Material metaphors as signposts for interpretation

Handmade cues can guide and influence the interpretation of the instance of mobile interaction trajectories. I call these cues *material metaphors*, because they use expressive details in the handmade parts of the space-time diary to represent the central message of an instance of mobile interaction trajectories. It is a *material figure* that can be used to communicate a curated Probe's core information. During the Probe's curation for the design workshops, I realised that some of these material metaphors guided my focus towards one theme. In such cases the presented instance was aligned with such material metaphors.



Figure 8.8: Couple MRS3's space-time diaries. Left: Her stitching shows one thin thread. Right: His shows multiple stitched paths. The different appearance of the stitching was chosen to be a representation and expressive metaphor to indicate their imbalanced mediated communication.

Example 1 - metaphor for communicative imbalance: The couple MRS3's communication was unbalanced. MRS3b (he) was the proactive part of their mediated communication. MRS3a (she) was the reactive part. Figure 8.8 juxtaposes their two space-time diaries. MRS3b (he) did plenty of stitching. He indicated several paths and also started a second space-time diary before the end of the recording week. In contrast, she came up with only one thin blue thread. She used as minimal time as required to stitch as she did to proactively maintain her relationship. For the Probe's curation, their unequal use of the materials introduced

a material metaphor that allowed communicating and pointing at their unbalanced mediated interaction. The material figure represented their communicative imbalance well.

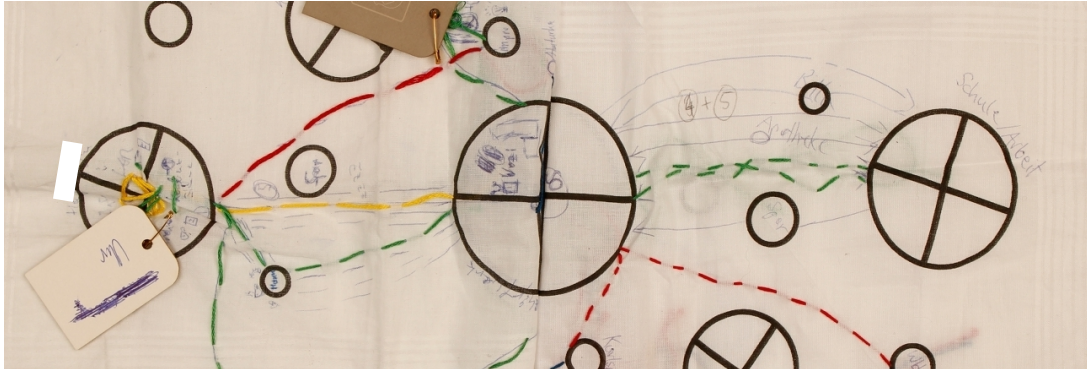


Figure 8.9: Couple MRS1 space-time diaries. Both participants swapped from stitching to using a pen to indicate their daily path to work. This was interpreted as a material metaphor that represents the repetitiveness of this routine-path to work

Example 2 – metaphor for an everyday routine: The couple MRS1 are both teachers in their day job. At the beginning of the recording period, they both started stitching their daily path to work (Figure 8.9). After the first day both of them chose to switch to pen to indicate their daily commute to work. They have to do this path over and over again. Using a quicker medium to indicate this path was enough for the rest of the week. By changing from needles and thread to pen they somehow indicate that this path is - although nice - a repetitive one and 'nothing special'. I used this material metaphor to introduce their repetitive journey to work for the presentation of the scenario in design workshops.

In some cases, a material metaphor was visible at first glance. Other metaphors were not so clearly visible, but rather emerged through the on-going interaction with the interview quotes and the space-time diaries. The material metaphors however guided the development and evolution of the main theme that was chosen for the presentation of the instance. Material metaphors offered a visible and tangible rationale for the selection of one particular theme.

8.3 Conclusion and discussion

The analysis revealed and clarified the value of the Probe's fabric format in design workshops. Findings are presented in Table 8.1 and are then summarised in this section.

Findings:	Contribution to Knowledge
<ul style="list-style-type: none"> • Handmade Probes communicated a sense of authorship, appeared as affective 'data', captivated designers and were perceived as interactive/'flexible' insights. • The handmade Probes' degree of subjectivity was (sometimes) received sceptically, but communicated a sense about the Probe respondent and the presented instance of mobile interaction trajectories. • Handmade Probes introduced material metaphors that guided the Probes' curation. 	<p>The value of fabric-based handmade Probes' for design communication is shown:</p> <p>Fabric-based handmade Probes introduce insights in a captivating authentic flexible format that requires subjective interpretation and guides the exploration of insights via material metaphors.</p>

Table 8.1.: Chapter 8's findings showing the fabric-based handmade Probe format's value for generative design processes

The handmade space-time diaries motivated and guided the Probes' exploration and introduced empathic elements arising from the Probe's fabric and handmade format in design workshops. The artefacts' authenticity and genuineness drew designers' attention to the space-time diaries. This enticed the design teams' to focus on trajectories, places and locations. Chapter 6 reported a high number of design concepts and design visions referring to these aspects. Using handmade space-time diaries influenced this result. However, the uncertainty and subjectivity that designers felt when dealing with the handmade space-time diaries influenced their work with the instances of mobile interaction trajectories too. Nevertheless, this insight does not refute the conclusions about the middle range theory's value for generative design processes. In contrast, Chapter 7 showed that designers' own experience (related to similar situations and contexts of mobile device use) and their subjective interpretation was a relevant source for articulating design ideas. Therefore, dealing with this subjectivity, designers augmented and consolidated the presented instances of mobile interaction trajectories. Still, this made them deal with realistic scenarios within the theoretical frame of mobile

interaction trajectories. The required subjectivity did not falsify the presented instances for generative design processes, nor did it diminish their quality for insight communication – also because the subjective space-time diaries were accompanied by additional and explicatory sources like annotations, summaries and quotes.

The results show that handmade Probes can readily have particular characteristics that make them suitable for generative design processes. The results revealed a twofold influence.

First, the format enhanced the Probe's appearance in particular ways. The handmade style augmented the sense of authorship, and the impression of the Probe representing *real data*. This made the curated Probe appear as a personal item and introduced a sense of *presence*. As described in Chapter 5, the Probe's fabric format, including its handmade style, aimed to achieve a sense of originality. The results described in this chapter show that this aim was achieved.

A minority of designers encountered the handmade style and the fabric as a flexible manipulatable interrogatable form, and also affective as opposed to purely cognitive (as with descriptive text). These aspects arise from the physical nature of the Probe, with its visible traces of *making and manipulation*. Such marks are evidence for the actuality, physicality and embodiment of the maker. Stitching and embroidery require physical motion in three dimensions. The resulting three-dimensional space-time diary therefore reminds designers about the respondents' embodied personification. The physicality of making and the three-dimensional nature endows the completed space-time diaries with an appearance that communicates rich insights into respondents that are not just data items. Visser (2011) argued that *showing real people* is one of design communication's key requirements. The research and analysis presented in this chapter indicates that the fabric-based handmade Probes introduced this sense of a *real person* behind the presented data.

Further, the space-time diaries' distinctive handmade appearance caught designers' attention and interest. Engaging designers and making them interested is one key aspect of successful design communication (Visser, 2011). As described in Chapter 5, the fabric format was chosen to introduce a sense of novelty that can trigger interest in the Probe, and it did achieve this objective as a

result of the recognisable individuality with which the handmade time-space diaries are presented, but also a result of the uniqueness of the fabric-based Probe as a whole. Simply put, designers had not worked with something like this before and were keen on exploring the curated Probe. Part of the interest originates from this sense of novelty. The analysis showed that the space-time diaries were able to capture attention and interest due to their handmade format. The Hankie Probe's fabric format itself influenced designer's interest positively. Having said that, repetitive use of the same format with the same groups of designers could reduce interest and attention.

Secondly, the handmade style required designers to subjectively interpret the stitched and embroidered space-time diary. The handmade style added another layer of interpretation that needed to be interrogated. As described in Chapter 5, this was an anticipated influence on the work with the fabric-based Probes. However, this layer introduced ambiguities that lowered the usability of the artefacts for some designers. The examples and quotes in the analysis showed designers' concerns about the quality and correctness of their interpretation. Fewer designers felt explicitly positive about this flexibility and freedom of interpretation. This limits the use of handmade Probes for probing and generative design workshops with design approaches that understand probing as a problem identification and problem solving activity⁶⁴. Handmade Probes are unsuitable for realist research values that require accurate reliable representations.

Nevertheless, comments show that designers - although refraining from over-interpretation – could gain useful insight from the handmade space-time diary. They made assumptions about the respondent's personality and the described instance of mobile interaction trajectories, based on the overall impression of curated Hankie Probes but also based on individual handmade details on the space-time diary. The individual style that respondents wove into the space-time diary, and how they used the Probe-space, became the trigger for designers' reflections.

⁶⁴ Dorst (1997) describes design processes that are understood as *rational problem solving*, located in a positivistic frame of thought. A design process is interpreted as addressing rationally described design problems. The designer is a goal-seeking information processing system. *Reflective practice*, instead, defines design processes as a reflective conversation with a design situation. Each design situation is unique. Designers move through a process characterised by consecutive problem reframing, decision-making and evaluating until a desirable design outcome is achieved. Designers' subjective perceptions of the situation (or world) are a relevant factor. The design problem lacks full descriptiveness (also see Chapter 2).

Designers were uncertain about how to interpret the handmade space-time diary, which triggered curiosity and discussions about possible interpretations. These discussions did not produce definite objective answers. At this point of the design workshops, the value of *perceiving* everyday objects came into play, which Csikszentmihalyi and Rochberg-Halton (1981) describe. *Perceiving every objects* refers to people's active receptivity to everyday artefacts, which may modify and affect previously formed understandings of the self or the world. Similar was the case in the design workshops. Interacting with the handmade Probes helped designers developing their understanding of the person and the instance of mobile interaction trajectories. The difficulty and uncertainty led to a discussion of 'what the artefact could' mean, who the person 'could be' or how the instance 'could be interpreted'. The diversity of potential meanings evolved into discussions and thoughts about the person or the instance of mobile interaction trajectories. The discussions led to a range of impressions, opinions and possible interpretations. This is the opposite of identifying a problem and describing it well, but instead made the insights about users and contexts appear as more versatile, offering a variety of potential meanings. As generative design processes look for opportunities rather than problems, the handmade space-time diaries' uncertainty can be a positive rather than negative quality.

The handmade impression of the Probe, along with various details on the space-time diary, triggered assumptions, interpretations and discussions. The meaning of the space-time diary arose from this interaction with the curated Probes and also from debates amongst the designers. This can be understood as *dialogical interaction* with the handmade space-time diaries (Miller, 2008; Csikszentmihalyi and Rochberg-Halton 1981). An object's meaning is not inscribed and hard-coded. Rather, meaning arises from discussion and interaction with it. In this dialogical process, the individual and handmade space-time diaries were a source of uncertainty, but at the same time this uncertainty, which was introduced by the Probe's fabric format was a source of debate about potential meanings and possible interpretations. The handmade style – how respondents recorded and expressed – was therefore a source of insight.

This analysis confirms Batterbee and Mattelmäki's (2002) research about the empathic value of Probes, and also Gaver et al.'s (2004) argument in favour of the 'value of uncertainty'. The findings also confirm Mattelmäki's (2006) emphasis on the importance of recording formats that allow individual expression, which

designers find inspiring. The findings presented in this chapter, however, relate this general value of probing (uncertainty, empathy, etc.) to the actual Probe format for data collection and expression, e.g. formats and practices that allow open and individual expression of insights and personalised forms of completion. Not only *what* is recorded but also *how* it is recorded affects the Probe's value, because recording formats that allow individual forms of expression introduce additional sources of insights. The practices, which have been successfully exploited in this research, offer this value. The Hankie Probe' fabric format enabled responses showing a twofold value for interpretation. First, *what* people said led to a discussion about the person and the scenario. Second, *how* respondents recorded - the formats and techniques they used to express insights - were an equal source of insights.

Chapter 9: Summary and Conclusion

This thesis developed one primary and two secondary research strands. Tables 9.1 and 9.2 summarise the thesis' research contributions. Further, this concluding chapter will revisit the three research strands to both summarise, and add a broader perspective on the thesis' results. It will also reflect on the research *through* design approach that guided this research during Stage 1 and 2, summarise the contributions to knowledge and discuss the thesis' limitations and future work.

9.1 Novel mobility theories for generative design work

9.1.1 Novel mobility theories and mobile interaction trajectories

The main research strand was motivated by the current theoretical discussion of alternative notions of mobility within HCI. Predominant theoretical perspectives on mobile interaction design remain rather conservative. Work by Fallman, (2003); Kakahara and Sorensen (2002) Dourish and Bell (2011) and Juhlin and Weilenmann (2013) make use of new theoretical perspectives for design, as discussed in *Chapter 2 Contextual Literature Review*. However, considering the large amount of research in this area, there has been a limited response to new theoretical possibilities within mobile HCI's. Mobile interaction design can still benefit from further work in this area. Chapter 2 also revealed that generative design approaches, like probing, have so far not been used to enable and explore novel mobility theories' value. Exploring and researching this potential became the central motivation for this thesis.

No unifying new mobility theory exists. Whether emerging from sociology, media studies or interaction design, each perspective emphasises different aspects of new forms of mobility. One overarching theme in these approaches however, is the rethinking of the notion of place. Space, according to these theories, is increasingly replaced by time as the main factor structuring social interaction. In other words, people are able to communicate with distant others *when* they are available via communication media, and do not necessary need to be in the same location to do so. This shift takes place because novel communication technologies allow the transcendence of space and theoretically speaking, humans can nowadays be connected to anybody, whenever they want, independently from where they are.

Communication technologies are the *tethers* between people and influence the practice and experience of communication, but also the way humans perceive distant others. Researchers such as Dourish and Bell (2011) or Kakiyama and Sorensen (2002) adopted the term *fluidity* to describe this increased importance of time over place. A similar position became central to my research too.

I introduced the middle range theory of *mobile interaction trajectories*. Chapter 3 elaborated on the theory's theoretical background and its differences to existing perspectives on mobile interaction design. It is a perspective on novel mobility theories for mobile interaction design, which is informed eclectically by contemporary research in media studies, sociology, social geography, and also by interaction design. The theory's core was developed at the early stage of this research but as this research went on, it kept developing. Mobile interaction trajectories strongly root mediated communication in people's individual trajectories, with a particular emphasis on embodied users roaming across several places in their everyday life (home, work, etc.). In doing so the theory overcomes (single) location-centred perspectives within HCI. The theory emphasises *fluid interaction*, which refers to being connected to various places and people continuously. The theory does not interpret these connections as static, nor as taking place simultaneously. It considers mediated communication with other people as rooted in everyday trajectories and in the context of the 'things' that people do. The structure of everyday life fragments and orders *fluid interaction* with others.

The middle range theory assumes that being on their individual trajectories, people have developed particular practices to maintain and manage their mediated communication. During their individual trajectories, people practice and experience periods/moments of connectedness across different places and contexts of everyday life. In these periods/moments, the *locative* and *mediated context* merge into a *blended context*. Thus, *mediated contexts*, e.g. people, places or information, become temporarily present and relevant. The theory acknowledges that people practice and experience their virtual ties particularly during everyday life, framed by social, activity or physical circumstances, which are prohibiting, interrupting, structuring or enabling these mediated communications. Mobile interaction trajectories draw from those practices and related experiences to inform and inspire design.

Current / Gap	Thesis' Aim	Findings	Contribution to Knowledge
Primary research strand: The value of mobile interaction trajectories for mobile interaction design			
New theoretical perspectives on mobility remain underexploited for generative design research.	Articulate a new perspective of novel mobility theories for the purpose of generative design research.	The theory of <i>mobile interaction trajectories</i> was presented in Chapter 3. The theory has two distinct characteristics: <ul style="list-style-type: none"> • A trajectory-based perspective that interlinks places of everyday life. • A focus on practices and experiences of changing states of connectedness, chronologies of mediated communication and mobile communication routines. 	<ul style="list-style-type: none"> • The middle range theory of <i>mobile interaction trajectories</i> itself is a contribution to knowledge. • The 10 instances of mobile interaction trajectories are a contribution to knowledge, materialising the middle range theory for practical design settings via design resources. • The middle range theory of mobile interaction trajectories inspires and informs generative mobile interaction design processes. • Mobile interaction trajectories' trajectory-based perspective inspires and informs generative design processes through its focus on physical mobility, practices and experiences of changing states of connectedness, chronologies of mediated communication and mobile communication routines.
	Present a design resource portfolio expressing real-life examples of the new middle range theory.	Chapter 5 presented 10 instances of mobile interaction trajectories , collected via two probing experiments using a design resource, called the Hankie Probe.	
	Evaluate the middle range theory's value for inspiring and informing generative design processes in practical settings.	The analysis in Chapter 6 has shown that curated Hankie Probes expressing <i>instances of mobile interaction trajectories</i> inspired and informed generative design work.	

Table 9.1: A Summary of the thesis main aims, outcomes and contributions to knowledge (primary research strand)

Current / Gap	Thesis Aim	Findings	Contribution to Knowledge
Secondary Research Strands			
The design process with Probes is understood as a <i>black box</i> .	Research the characteristics of the design process with the curated Hankie Probes and identify other influences on the design teams' processes.	<p>Characteristics <i>of</i> and influences <i>on</i> the design process:</p> <ul style="list-style-type: none"> • The curated Probes were used in iteratively evolving design processes • The curated Probes introduced <i>theoretically and thematically</i> framed instances of mobile interaction trajectories. • The instances offered scopes for exploration. Design teams focused on scopes during their design process (and changed focus consecutively). • The instances of mobile interaction trajectories introduced selectable reference points for synthesis and analysis (evaluation) of design visions and concepts. • In the design setting, the curated Probes were augmented by designers' experience, subjective interpretation and design skill. • The Probe design itself and the respondent's personality influenced design visions and design concepts. 	<p>A new theoretical understanding of probing is proposed:</p> <p>In design settings and during an iteratively evolving design process, Probes allow designers' dialogical interaction with insights about users and contexts, offering a theoretical and thematic frame, scopes to focus on, and selectable reference points for synthesis and evaluation of design visions and design concepts.</p>
The value of fabric-based handmade Probes for design communication has not been researched yet.	Research the qualities of fabric-based handmade Probes in generative design workshops.	<p>The Probes format's influence on the design process:</p> <ul style="list-style-type: none"> • Handmade Probes communicated a sense of authorship, appeared as affective 'data', captivated designers and were perceived as interactive/'flexible' insights. • The handmade Probes' degree of subjectivity was (sometimes) received sceptically, but communicated a sense about the Probe respondent and the presented instance of mobile interaction trajectories. • Handmade Probes introduced material metaphors that guided the Probes' curation. 	<p>The value of fabric-based handmade Probes' for design communication is shown:</p> <p>Fabric-based handmade Probes introduce insights in a captivating authentic flexible format that requires subjective interpretation and guides the exploration of insights via material metaphors.</p>

Table 9.2: A Summary of the thesis secondary aims, outcomes and contributions to knowledge (secondary research strands)

As discussed in Chapter 3, the presented theory shares common ground with other existing interpretations of novel mobility theories within interaction design, e.g. with *mobility as involvement* (Fallman, 2003) or with the concept of *fluidity* as discussed by Kakiyama and Sorensen (2002) and Dourish and Bell (2011). Nevertheless, the theory differs from these theoretical perspectives in its focus on *trajectories* and *fluid interaction* expressed as changing states of connectedness, chronologies of mediated communication and mobile communication routines.

9.1.2 A theory for practical design settings

With a focus on practical design settings, the aim was to articulate a middle range theory that shows a manageable degree of complexity for the purpose of generative design processes with Probes. In other words, the most intricate theory is useless for design if it cannot be grounded in practical design settings and be applied via design resources. It was therefore the aim to articulate a middle range theory based on the core thoughts of novel mobility theories, but on a level and in a format that can be converted and adapted in a usable way to different application domains and practical design settings.

The design of the Hankie Probe played an important role for articulating and elaborating *mobile interaction trajectories*. The Hankie Probe needed to be adapted to the requirements of design settings, comprehended and used by Probe respondents. Designing the Hankie Probe helped developing the middle range theory for practical design settings and introduced a pragmatic design focus. This allowed finding the *middle range* between abstract theoretical concepts and practical design settings, in terms of how detailed and rigidly the theory is articulated. It also needed to be understood and worked by design teams in rather short design workshops. This meant finding usable and comprehensible representations of the middle range theory via design resources.

The tangible representation of mobile interaction trajectories via the Hankie Probes strengthened and highlighted particular theoretical aspects. Thus, the design of the Hankie Probe for disseminating and materialising mobile interaction trajectories shaped the middle range theory. For example, the theory's strong emphasis on *everyday trajectories* is (partly) a result of the Probe design itself – which will be reflected on in the next paragraph.

Using space-time diaries is a result of the creative design process during Stage 2 of the thesis research. Hence, designing the Hankie Probe was a way of elaborating theory. The Probe design aimed to cope with and integrate several aspects of novel mobility theories. Urry's mobilities framework (2007) was a central reference for mobile interaction trajectories, which argues for the *co-existence of physical and virtual mobility*. Likewise, the theory aimed to overcome a single location-based view of mobile interaction. Thinking in everyday trajectories offered a way to integrate these distinct theoretical 'requirements'. At the same time, everyday trajectories offered a solution to a practical requirement: They could be displayed via map-like space-time diaries. The notion of trajectories seemed to be, literally, a usable and adaptable baseline that could be represented with user and context focused design resources. Benford et al.'s (2009) work on interaction trajectories motivated and facilitated the application of *trajectories* to the mobility domain. However, the visual and tangible space-time diaries drew attention onto this theoretical aspect, turning it into one of mobile interaction trajectories' key elements. I can therefore conclude that the middle range theory was the scaffold for the Probe's design. In response, the Hankie Probes design elaborated some of mobile interaction trajectories' theoretical aspects, influencing their balance and prominence. Consequently, the completed Hankie Probe emphasises respondents' *physical mobility* (drawn and stitched trajectories), while their completed Probes feature *mediated contexts* less prominently.

Another example is the theory's focus on locative contexts. For the design of the Probe, and therefore – implicitly – for the design of the theory, I drew on Iacucci et al.'s work on inspiring mobile interaction design, which shows that insights about contexts, e.g. activities, places and artefacts, can inspire design directly. As a result, the middle range theory included such aspects prominently. Similarly, the practice-led design experiments shaped the theory. One example is the use of 'imaginative mobility', which referred to people being reminded of each other by digital means, e.g. facebook comments on other people's threads and non-digital signs like a picture of a person on an office desk (etc.). I used this concept for probing experiment one (stage 2 of the thesis research). However, I dropped the concept, since it did not show to have a strong influence on design work. It complicated the theory, but without adding value for design.

Mobile interaction trajectories presented via the curated Probes proved to be a good foundation for generative design processes. The analysis presented in Chapter 6

revealed that designers exploited mobile interaction trajectories' different aspects for their design work, which establishes the middle range theory's usability and adaptability for practical design settings. I conclude that the middle range theory is fit for practical design settings. Further, this shows that using a research *through* design methodology was an appropriate approach for elaborating the middle range theory for the requirements of practical design settings.

9.1.3 The completed and curated Probes

Chapter 5 combined the Hankie Probe's theoretical and practical basis as well as the completed and curated Probes into a *design resource portfolio*. The design resource portfolio presented the raw Hankie Probe as a user and context focused design resource, rather than as a standardised method for repetitive application. This presentation approach offers a basis that other design researchers can adapt and reuse, appropriating parts or single elements of the Hankie Probe for their own approaches. The portfolio's key feature was the discussion of completed and curated Probes, which gives a direct overview of where work with the Hankie Probe can lead to. The design resource portfolio is a way for communicating the middle range theory to the thesis' audience of design researchers. It expresses mobile interaction trajectories in a practical 'version' *for* design researchers.

The description in Chapter 5 aimed to explain the Probe's conceptual roots and provided insights for this resource's application in future design settings. It discussed the underlying middle range theory and considerations for this particular Probe design as well as the completed Probes' scope and content. Design (research) portfolios that illustrate and discuss designed artefacts inspired this presentation format. It enabled emphasis on the design researcher's theoretical stance, taste and preferred ways of working. It also embraced the need for design resources' contextualisation, emphasising that every design resource, from Probe to role-playing, requires adaptation to the particular design settings.

The core Hankie Probe design was utilised in two probing experiments, each focusing on a different application domain. Experiment one looked at mobile relationships; experiment two explored the topic of mobile work communication. The work resulted in 10 completed Probes that share common features and deliver three levels of insight: reports of movement and communication *practices* and accounts about movement and communication *experiences*. In terms of the content, the completed Probes communicated respondents' *trajectories*, their *practices and experiences of*

communication routines, chronologies of mediated communication and changing states of connectedness, they expose *places of communication* and partly explain the respondents' personalities, their activities in particular places, their work or relationships too.

The Probes managed to reveal and express recurring movement patterns and changing states of connectedness, chronologies of mediated communication and mobile communication routines, which are an inherited trait of mobile interaction trajectories. Completed Hankie Probes featuring one-off situations were rather the exception. In general however, the respondent's accounts sounded mundane and predictable at first sight, especially those about mobile communication routines in everyday life. Nevertheless, respondents' individual accounts and motivations enriched these mostly banal sounding routines. These accounts augmented their completed handmade space-time diaries and together they offered the curated Probes' actual value as starting points for generative design processes.

The Probes that were curated for, and used in, design workshops aimed to emphasise and highlight practices and experiences of mediated communication as well as physical movement patterns as starting points for design. The curation processes focused each completed Probe through the lens of mobile interaction trajectories. The supportive materials (summaries, visual annotations of the completed space-time diaries, selected quotes from the debriefing interview, etc.) highlighted the selected theme for presentation. The curation processes aimed to accent aspects in the theory's favour and was driven by the thesis researcher. The curation processes sought to achieve a sound and balanced selection of topics for the 5 curated Probes in each probing experiment. The resulting 10 *instances of mobile interaction trajectories* are expressed via curated Probes, including summaries, annotated space-time diaries, respondents' quotes collected in debriefing interviews and a short persona description. These are real-life examples illustrating the theory of mobile interaction trajectories.

9.1.4 Designing with mobile interaction trajectories

Chapter 6 has shown how mobile interaction trajectories' aspects support generative design work. I therefore conclude that aspects of novel mobility theories can inform and inspire generative design processes. In particular, mobile interaction trajectories offer new perspectives that mobile interaction design and mobile HCI can benefit from.

The analysis revealed that design team's responses to the presented instances of mobile interaction trajectories led to design concepts with the following characteristics:

- Services and devices that change the chronology of being connected to distant others
- Communication technologies that show a high degree of contextual adaptation.
- Communication services that interlink people's individual trajectories with each other.
- Digital devices proposing new media-formats for everyday communication.
- Services that help manage and visualize hyper-connectivity and the chronology of connectedness.

The most prominent and most often articulated vision was to provide contextually adapted systems that provide new *communication experiences* (introduced by new forms of communication media) and to *disrupt and reorder the chronology and locality* of being connected. Design teams however also proposed services that *visualise and allow managing* the chronology of mediated communication over the course of a day. The Probes, especially those of probing experiment one, led to concepts and services that sought to interconnect people's individual trajectory with electronic media on a practical and emotional level.

A closer look at the actual design processes supports a deeper understanding of the middle range theory's value for generative processes. The design teams drew from respondents' trajectories, which introduced a range of places to design for. These aspects were a source of design visions. They allowed the design teams to consider the place for their design intervention and provided an evaluative frame for ideas. For example, designers wondered about places that provide the best conditions for a design intervention. Likewise designers evaluated their ideas by envisioning what the respondent's trajectory could look like after their design intervention. This is a novel practice for mobile interaction design. Single-location and device centred perspectives on mobile interaction design cannot encourage such practices, since they either exclude contextual aspects or don't embrace a multi-place view, but rather concentrate on one particular place from the outset. The value of multiple places as design options (which place should the design concept be directed at...) and evaluating futures (how will this service play out across different places...) is not recognised by single-location perspectives. This thesis research, however,

emphasises the value of a trajectory-based perspective for generative mobile interaction design. The evaluation of this feature is a contribution to knowledge.

Chapter 6 showed that mobile interaction trajectories' second main aspect, namely expressing *fluid interaction* as practices and experiences of changing states of connectedness, chronologies of mediated communication and mobile communication, is a source of design vision and concepts as well. Existing interpretations of novel mobility theories have described and theorised about *fluid interactions*. Mobile interaction trajectories propose an everyday perspective on *fluidity*, expressing mediated communication as embedded in everyday trajectories. The analysis in Chapter 6 revealed this aspects' value for generative design. In the context of this research, such insights inspired concepts aiming to disrupt and reorder the chronology and locality of being connected. This too is a contribution to knowledge.

Further, the analysis in Chapter 6 revealed the function of *contextual experiences* (how do people experience a place) and *contextual artefacts* that the Probes exposed. Each Probe collected these types of insights and communicated them to design teams. Both types of insight inspired and informed design processes as design references for visions and concepts. The research literature has shown these aspects to be essential aspects for mobile interaction design, albeit implicitly, e.g. by Iacucci (2002). This thesis research contributes to knowledge with a more intricate explicit exposure of how these insights function in generative design processes, classifying them as design references for design visions and concepts.

9.2 Secondary research strands

To identify the value of mobile interaction trajectories, it was necessary to consider design processes with Probes to show from which inspirations designers drew on, alongside insights from instances of mobile interaction trajectories themselves. This was the basis for understanding the Hankie Probes' value for generative design processes in a broader context. However, the research literature lacked a thorough and explicit discussion of how Probes fit and perform within the realities of early design stages, at least in relation to a design process and how it is theorised. The literature lacked an analysis of use of fabric-based handmade Probes used for design communication too.

The analysis in Chapter 7 revealed typical traits of design processes distinguished by iterated cycles of synthesis and analysis, leading to design teams' rather iteratively evolving exploration of the presented insights about users and contexts. This mirrors the description of design processes from various authors, e.g. Cross (2006), Löwgren and Stolterman (2004) or Lawson (2006). In this context, the analysis showed that within a design process, the curated Hankie Probes have three functions. First, the curated Hankie Probes presented *theoretically and thematically framed instances of mobile interaction trajectories*. Secondly, the curated Probes propose a number of *scopes for deeper exploration* within these instances that act as starting points for evaluating options for design. Design teams changed their focus on these scopes during their design process. Chapter 7 discussed this aspect to aid designer divergence, which has been reported to be one of design processes' intrinsic characteristics by Löwgren and Stolterman (2004). Thirdly, when the design teams change focus and explored different scopes during their process, the Probe provided *selectable reference points* for synthesis and evaluation of emerging design visions and design concepts. Selectable reference points are understood as particular details in the presented insights, e.g. a single quote or a particular drawing on the completed space-time diary (etc.). Thus, the design teams developed design concepts in response to the presented instance, but used particular details about users and contexts to develop and inform their work and to argue for or against a particular design vision or design concept. This explicit articulation of Hankie Probe functions in the design process is one of this thesis' contributions to knowledge, showing Probes' functions in design workshops, which have previously not been reported.

Chapter 7 further discussed other influences on the design teams' process. The instances of mobile interaction trajectories were augmented with contextual insights, such as designers' own experience with similar situations of mobile device use, the Probe respondents' personality and the Probe artefact's aesthetics. The analysis also revealed the importance of designers' experience and design skill, but also the relevance of their subjective interpretation for the articulation of design visions and design concepts. The analysis however also exposed that the design process could appropriate from the curated Hankie Probe itself, e.g. its graphic design, which for example was used for the conceptual layout of an ambient display. Hence, the instances of mobile interaction trajectories introduced a theoretical and thematically framed scaffold that was completed via contextual insights coming from the design setting. Based on the findings in Chapter 7, the thesis research proposed an interpretation of design processes with Probes as a dialogical interaction with insights about users and contexts – in line with the perception of other design practices, like

design sketching (Lawson, 2006). It can further be argued that completed Probes only unfold their full potential once they are combined with the designers' private and professional experiences and with their design skill.

In Chapter 8, the analysis looked at the fabric-based handmade Probe format, focusing on the handmade space-time diaries in particular. The analysis' aim was to understand how the use of fabric that enabled practices like sewing and stitching influenced the design processes. The findings revealed the resulting handmade Probes to have introduced a sense of authorship. The respondents' individual handmade style led to a sense of presence of their makers (the Probe respondent). This created an appearance of *real-data* and turned the Hankie Probes into a proxy that stood for and represented the Probe respondents during the design workshops. The fabric-based format's most prevalent function, however, was to catch designers' attention, which was partly due to the novelty of the artefact and the rather atypical media choice. Nevertheless, this function turned the completed space-time diaries into a trigger to engage with the curated Probes and to explore the presented instances of mobile interaction trajectories.

The fabric-based handmade format influenced the design teams' work with mobile interaction trajectories. The Hankie Probes' captivating format drew them towards respondents' space-time diaries. This (partly) explains design teams' attention to places, locations and trajectories. The findings about mobile interaction trajectories are influenced by this focus on trajectories and locative contexts. Another Probe format would probably shift attention on other aspects, such as mediated contexts or periods/moments of connectedness.

The main concern about the format was its subjectivity. The fabric-based format formed a semantic level for interpretation that needed to be interrogated. Some designers were unsure of how to interpret the handmade space-time diaries. Designers expressed their concern about false interpretation. The majority of designers worried about over-interpretation. A minority of designers welcomed the handmade space-time diaries' freedom of interpretation. This is a downside of this fabric-based format and limits its use in some disciplinary contexts. This circumstance is partly influenced by designers' backgrounds, which, in most cases, was a rather traditional HCI background. Participating designers were mostly trained in user-centred design, engineering and social science. Backgrounds in industrial design (or similar) were the exception. In traditional HCI sub-disciplines, design is often seen as a problem-solving activity rather than a process that searches for opportunities and

makes assumptions about users and contexts. According to this view, it is not the designer's task to assume what people might like or want in the future, but generative design work thrives on such assumptions. It can be argued that to a certain degree, the negative perception of subjectivity is due to the participating designers' disciplinary preferences, because most participating designers' had a rather traditional HCI background. Nevertheless, the increased need for interpretation (combined with designers' unease employing it) classifies fabric-based formats as less suitable for identifying and conveying clear problem statements. In such cases, fabric-based handmade Probes can only support and accompany insight presentations that are collected and communicated via more objective channels.

However, the data analysis showed that designers did not completely refrain from assessing meaning to Probe's handmade parts. The designers drew from the handmade details and also from the space-time diary's overall impression. Such aspects made designers think about the respondent's personality, but also conveyed a sense of the instance of mobile interaction trajectories that was presented. Thus, the fabric-based handmade Probe format was a source of debate about possible meanings of the completed space-time diary. The Probes' format was therefore also of source of insight – even if those insights did not lead to definitive answers.

The problems with subjectivity do not refute the conclusion about mobile interaction trajectories' value for generative design processes, since the curated Hankie Probes were presented together with other materials (quotes, summaries, etc.). Furthermore, designers completed the instances of mobile interaction trajectories with realistic assumptions informed by their own experience with similar situations (as it has been shown in Chapter 7). Although the fabric-based format made the instances appear less factual and suitable for *realist* research positions, the analysis revealed that the format was a source of insight stimulating discussions about possible meanings. This is an acceptable situation for generative design research that looks for opportunities rather than for concrete problem statements.

The discussion of fabric-based handmade Probes is a contribution to knowledge that shows their particular value for generative design research, but also that Probes' chosen format can be a source of insight too. The analysis in Chapter 8 concluded that the Probes' manifest qualities, such as their ability to raise empathy and their inspiring value, are intrinsically linked to the Probes' format and not only to their surprising and unexpected content. Compared to the current literature, these results

report a more intricate understanding of the Probes' role in stimulating empathy and inspiration. The thesis also showed that fabric-based handmade Probes offer this value to generative design work. This insight is another contribution to knowledge.

9.3 Contributions to Knowledge

With this thesis, I contribute a new theoretical perspective of novel mobility theories to the area of interaction design. Mobile interaction trajectories is not the first interpretation of novel mobility theories for interaction design. It takes a novel perspective and can therefore be seen as a contribution to knowledge. Further, I contribute to knowledge by showing the theory's value for generative design work.

The findings presented in Chapter 7 further contribute to knowledge. Based on the results I proposed a new theoretical understanding of probing, which sees work with completed and curated Probes as a dialogical discourse in design settings structured around theoretically and thematically framed insights about users and contexts during which the Probes provide scopes for exploration and selectable reference points for synthesis/analysis and evaluation.

The discussion of this format's value for generative design workshop is a contribution to knowledge. The analysis exposed the perception and use of the Hankie Probe's space-time diary as a handmade artefact. It revealed evidence showing that handmade Probes appear as subjective, but overall as an affective and attention-catching design resource. The limitations of this format have been found in its weakness at collecting and expressing clear problem statements, which make the fabric-based handmade Probes unsuitable as stand-alone devices for some approaches to insights communication.

9.4 Reflection on methodology and limitations of this work

9.4.1 Research through/about design as research methodology

The application of the programme and experiment approach adopted from Binder and Redström (2006) gave this research a basic frame for tracking and documenting the evolving understanding of the middle range theory and the Probe formats used in this thesis research (as discussed in Chapter 4). It was a helpful framework and worked as a basic guidance.

In retrospect, choosing a research *through* design methodology for the exploration, development and evaluation of a design resource was appropriate but challenging. The creative elements in such methodologies inevitably introduced some uncertainties throughout the research. The progress of this explorative approach was only roughly predictable at times, but offering a high degree of freedom and left outcomes open. For example, this thesis' focus on fabric-based Probes originated from the thesis researcher's creative design process during stage 1 of the research. The use of this format was not planned in the beginning and introduced new research questions, leading to an additional research strand. In this particular case, research strand 2b: the value of the fabric-based handmade Probes in design workshops.

This extended the time spent on data analysis, as the research question and potential claims (partly) emerged in parallel to the analysis of the data. This required some confirmatory analysis with adjusted objectives and questions. However, as research through design is strongly reliant on the designed outcome due to design's co-evolution of problem and solution spaces (Cross, 2006), the final analysis including its method of analysis cannot be finalised until the designed artefact is completed and used in evaluation settings. This delayed a final definition of thesis research outcomes and clarification of related research questions until the latter stages of this research. Lacking this well-defined research progress also impacted other stakeholders, e.g. supervisors. This complicated reviews of the research while it was in progress, since interim reflection activities are rarely conclusive.

The unavoidably creative nature of research through design rules out a complete initial plan. This leaves more freedom to 'try-out' and the primary aim is to achieve something that works in practical design settings. This motivated the early stages of this thesis research. Nevertheless, research *about* design (evaluation) had to become a concern at some point to balance creativity with rigour. This research thus sought to balance exploration and evaluateability of the results. This, however, limited the generalisability of the results, as they are a result of, and bound to, the practical design settings in which the thesis research took place. For a pragmatic understanding of design however, such limits to universal validity are accepted. It is accepted that design resources such as Probes need to, and will, be adapted to unique concrete design settings. This has several consequences, which are now explored.

On the positive side, the research through design approach can draw effectively on personal values and creative interests when designing and developing design resources. Using this approach acknowledged and unlocked the creative and innovative nature of user and context focused research activities. Early practice-led activities, rather than a prolonged theoretical analysis, led to a middle range theory that was adapted to practical design settings from the outset. In other words: the research *through* design approach favoured the development a middle range theory *for* interaction design. The practice-led research activities during stage 1 and 2 focused on the theory's applicability and usability for practical design settings. Hence, this theory originated *from* design settings rather than being appropriated *to* design settings afterwards.

9.4.2 Theory as shaped by practical settings

The design and work with the Hankie Probe is one way to develop and work with a middle range theory. The choice of fabric introduced a very experimental character to this research. To a certain degree, this limited the work with mobile interaction trajectories as theoretical constructs for generative design processes. For example, several designers expressed their concerns about the degree of subjectivity that these handmade Probes introduced. Of course, the theory of mobile interaction trajectories could have been explored using a more objective format, such as textual presentations, which may have led to different and perhaps unequivocal insights about the theory's value. However, the Hankie Probe's way of representing the middle range theory was 'close enough' and delivered value that may well have been beyond other more 'objective' formats.

The thesis considered a (hypothetical) situation within a research innovation project at a research centre or at a company. Designers participated for design workshops, which lasted for approximately two hours. They were not involved in the thesis research before or after these short events. Planning the insights collection with the Hankie Probes, it was not clear to which designers (with which individual backgrounds and skills) the curated Probes would be presented. This required working with rather general instances of mobile interaction trajectories, in terms of application domain (couple's mediated communication and mobile work communication) and of information depth for presenting the curated Probes. This limitation constrained the theory's development in two ways. First, the theory may miss requirements of specific application domains, making the theory unusable for

design work addressing exceptional users or contexts. Hence, mobile interaction trajectories may not include specific insights, which are however relevant for particular design contexts. Secondly, the rather short design workshops (and their analysis) exposed the theory's value for initial generative design processes. The design settings did not allow evaluating the theory's value in later design stages, e.g. when designers elaborate their initially formed ideas for design concepts. Hence, mobile interaction trajectories, as presented in Chapter 3 and expressed via the completed and curated Hankie Probes in Chapter 5, may be too general for later design stages that require a higher information depth and a greater amount of specific and detailed insights.

9.4.3. Risks and limitations of Probe curation

The selective curation process, driven by the thesis researcher, also introduced risks. My aim was to introduce a balanced and fruitful basis for the design workshops in terms of instances of mobile interaction trajectories, level of detail and presentation format. I drew from my experiences in previous research projects working with design resources to reduce these risks. Furthermore, I sought ad-hoc feedback from colleagues and other researchers to improve the curated Probes' presentation and selection of instances of mobile interaction trajectories. I also drew from research about design communication, such as Visser's (2009), to specify the right format and detail for the Probes' presentation. However, the three following risks were identified that had to be coped with:

First, there was a risk that designers *cannot familiarise* with all selected instances of mobile interaction trajectories. The analysis of design workshops presented in Chapter 7 shows that two Probes suffered from this weakness. For example, MWC3 worked in an industry that the designers knew little about. Designers expressed this concern during workshop H. Similar issues were visible with MRS2's curated Probe, where the instance of mobile interaction trajectories had little to do with the couple's completed space-time diary. Despite unfamiliarity or scepticism, designers worked with these curated Probes and presented a design concept too. These problems emerged during stage 2 of the thesis research. When this problem emerged, I decided not to use curated Probes MRS2 and MWC3 for other design workshops.

Second, there was a risk that design teams would find the *level of detail* and the *presentation format* inappropriate, e.g. the amount of quotes included in the curated

Probes, the level of detail used for the summary, the Personas description, the mix of handmade space-time diaries, and textual and visual information printed on cardboard. In this respect, the analysis of design workshops presented in Chapter 7 identified the curated Probes' format as appropriate. Designers referred neutrally or positively to curated Probe packages. No negative influence of the presentation format was observed.

Third, there was the risk of *over- or underrepresenting mobile interaction trajectories' theoretical aspects*. The challenge was to find a right balance between the middle range theory's theoretical aspects. The space-time diary emphasised respondents' trajectories, hence their physical mobility and locative contexts. Probe respondents' mediated contexts and their related changing states of connectedness, chronologies of mediated communication and mobile communication routines were less salient. Therefore, the curation process aimed to balance the risk of underrepresenting respondents' mediated contexts and related practices and experiences by visually annotating the completed handmade space-time diaries. The annotation highlighted moments and periods of connectedness, introducing respondents' interaction with mediated contexts more explicitly. Nevertheless, Chapter 7 showed that the prominent visual and handmade space-time diaries created a strong focus on respondents' physical mobility, which influenced the design processes. This is a limitation of this work.

9.4.4 Results' validity and generalizeability

The raw, completed and curated Hankie Probes are very specific examples that exemplify the middle range theory of mobile trajectories through the activities of Probe respondents. The Hankie Probe's design, its application and analysis are bound to and the result of specific design settings. There is no guarantee that the raw Probe design will transfer to any similar future design settings. However, this outcome contributes to the understanding of generative techniques by offering alternative approaches to mobile interaction design and new perspectives on novel mobility theories and their possible manifestations via Probes. Any re-use in different settings and for different application domains will require adaptation. Chapter 5 aimed to support such adaptation through a general discussion of the resource's theoretical background, its design, etc. This should allow other design researchers to apply this middle range theory and the Probe format to their project and research settings. It thus delivers a *competence* (Keinonen 2009), rather than a completed re-usable *instrument* that can be used without changes.

The validity and reliability of empirical results presented in Chapter 6 to 8: The transferability of insights across design settings is a general problem of research through design and, in particular, an issue when it looks at user and context focused design resources. Highly specialised evaluation criteria for design resources could allow confident results for specific design settings, e.g. a focus on designers with particular heterogeneous backgrounds, etc. While they are valid for one setting, such results cannot be transferred to other settings with key differences. In contrast, uncontrolled settings reduce confidence in insights because they are too vague, with influential variables unspecified. For uncontrolled settings, no clear statements can be derived. This thesis research tried to balance these two extremes. The Probes were investigated neither in too narrow, nor in totally uncontrolled design settings. This situation was achieved by conducting the thesis research in *realistic* interaction design settings, in terms of characteristics of participating Probe respondents and designers and in terms of practical settings, but without narrowing the research approach to a lab-like situation.

The participating designers' backgrounds and professional experience are located in the area of HCI and interaction design, showing heterogeneous characteristics within this area of expertise. Also, the design settings in which the curated Hankie Probes were used can be interpreted as *typical enough* in regards where Probes are normally used. The design workshops were conducted at research centres that offer a representative distribution of expertise and skills of contemporary HCI research. The distribution of skills and backgrounds amongst the designers participating in the design workshops was managed with an open invitation policy.

The design workshops defined the setting generally, but the design teams were given the freedom to explore the presented insights about users and contexts as they wished during the workshops. A realistic setup would not prescribe how, when and in which way to look at data materials. The presented results need to be judged in the context of these practical design settings.

Given this heterogeneity, designers and teams reacted differently to the curated Probes. Participating designers were free to choose their level of involvement in the group. The results therefore indicate the potential value of the Probes within such heterogeneous design settings. The analysis of the design workshops applied the rigour of qualitative research. The results are at least valid for the design settings in which they were researched. In terms of transferability and general validity, the

heterogeneous group of designers and the open, but realistic setup of design workshops generated results that should be valid beyond their origins - even if they cannot be generalised for every imaginable design setting. The reported results represent value that is achieved in design teams and design workshops with comparable characteristics. It is reasonable to claim that the middle range theory's and the Hankie Probe's value will emerge in future settings too. Each particular design setting however will influence the extent of this resulting value.

9.4.5 Further considerations

This work sees Probes (almost) as data: Much of the Probes' value emerges through the interaction with Probe respondents, with the actual Probe artefacts being the enabler and mediator for this interaction, e.g. Mattelmäki (2006) and Wallace (2012). This is how probing is often interpreted. It supports new forms of researcher-respondent relationships. Insights for new design visions and concepts emerge during this direct interaction with Probe respondents. The setup of this research limited participating designers to analysis and use of the curated Probes to fixed design settings, with no access to respondents. An artefact that would usually be an enabler became the main form of actual data and the object of the designers' research. This is a limitation of the thesis research as it excluded the direct interaction of designers with Probe respondents. However, for the purpose of this thesis research, it seemed valuable to keep insights collection and insights communication apart, and thus the design workshops focused explicitly on the curated Probes. To compensate for the lack of direct interaction with the Probe participants, the curated Probes included additional material (quotes, summary, etc.). That aside, the split between user and context focused design research and insights communication is a common one in academic and industrial settings. Literature reports research that was done in similar setups keeping insights collection separated from insights use in design workshops. For instance, Visser (2011) used a similar setup for her research and also Mattelmäki's research (2007) shows various situations in which design processes take place separately from insights collection and which therefore also exclude the benefits of direct respondents-designers interaction.

Focused on social interaction: The middle range theory of mobile interaction trajectories is strongly influenced by theories from contemporary sociology and media studies. They have a strong focus on social communication, which is also what drew the focus of this research towards this aspect. This may limit the reported results to generative design work that looks at social mobile communication. The middle range

theory currently excludes aspects of mobile device use that goes beyond social interaction.

9.5 Future work

This research explored the middle range theory of mobile interaction trajectories, looking at two particular application domains: couples' mobile communication and mobile work communication. Future research needs to look at further topic areas to test the theory's applicability across diverse domains. This can extend the data corpus for an exploration of the middle range theory's and the Hankie Probe's value.

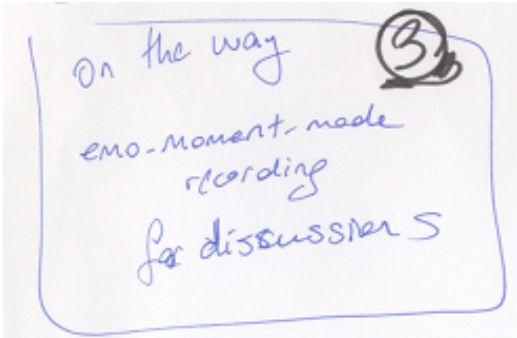
Furthermore, future work could investigate insights about users and contexts that include *groups of multiple people communicating* with each other during their routines as a group. The applicability of mobile interaction trajectories in such multi-actor situations needs to be explored.

Future research also needs to explore *different ways to work with mobile interaction trajectories on a practical level*. The Hankie Probe is one possible way for applying this middle range theory, but it could be exploited within other forms of design resources, e.g. storyboards, personas, role playing, etc. Generally speaking, research can look at multiple ways to collect and communicate mobile interaction trajectories, e.g. even by statistical means using GPS and location tracking or by approaches that make use of digitalised self-recording techniques like video. Expressing mobile interaction trajectories through different means can also affect the theory's appearance. For example, the approach that was used in this thesis research introduced a strong focus on physical mobility. In other words, mediated communication was researched in the context of physical mobility and not vice versa. This influence was also recognisable in design workshops (see Chapter 6 and 7). A more balanced representation of locative and mediated contexts can show new insights.

Future research on Probes as part of the design process can show a broader perspective on Probes' functions in relation to design work. The presented thesis research is based on work with groups of designers, who have a strong background in HCI. In future it can be researched how *groups with other design-backgrounds* respond and deal with the same curated Probes. Future research can also link a resource's value to particular team formations and to a designer's personal or professional characteristics. Further activities should also look at longer design

workshops, or a number of design workshops over time to see how the reported Probe functions evolve over time. In a similar way the design of the Hankie Probe can be researched in longer workshops to establish whether the captivating appearance reduces over time.

Nr	Design Concepts		Designer & Workshop	Probe	Attributes
1	<p>Interactive Jukobox-dice: A playful way to suggest activities for the evenings.</p>		2A	MRS1	<p>2 x Relates to the described practice of work or content of communication (decision support of what to do – jukebox: randomly generated suggestions of what to do)</p>
2	<p>Naughty stickers: A little printer that delivers random fictional stories that entertain and suggest “what to do in the evening”.</p>		2A	MRS1	<p>Contextual adaptation (sticky notes)</p> <p>Relates to the described practice of work or content of communication (randomly generated suggestions of what to do)</p>

3	<p>Emo-Moments Recorder: Allows to record emotional moments 'on the go', and when separated. Allows to share private recordings and to store them for later.</p>		2A	MRS1	<p>Change the chronology of communication (storing communication events, and making them available later)</p>
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4
-
6

ensemble 1: mobile routines
decision space
↳ influenced by medium
20/30 ; users; not technological advanced
preferences: talking to each other
slide notes on the table

Background info

- easy breaking the routines
↳ examples are adjusted to the users
↳ like breaking the routines

Example 1:

TOUCH YOU
BUTTON (YO) USE

- + no audio output
- + flexible in time & environment
- + adjustable to routines OR also breaking the routines
- + small & easy to you
- + simple & advanced version
- looked more colors
- + colors of lights can be set by users or depending on, features according to representation of moods



Interaction from user 2 to user 1

- I will be available to talk in 10 min.
- Let us meet at home
- I will be delayed and arrive later
- Let's discuss an alternative ^{to meeting at home} ~~meeting plan~~ (e.g. cinema, restaurant)
- I love you
- I have a surprise for you
- ● recognized not recognized

MESSAGE IN A FLOWER & MESSAGE IN A BOTTLE with mobile

→ sending a virtual flower bouquet and virtual beer bottles on the mobile to get in contact & transfer semantic messages

Mobile:



message from Stroble to Susi

- why? Because women like flowers & men like beer
- possibilities: *color of the bouquet / message represented by a color of the bouquet or the beer brand
- * represented by flower typology (e.g. no real roses = love...)



message from Susi to Stroble

"Button (Yo) Use": a service to send predefined written messages to partner,
"Message in a Flower/Bottle"-App: A service that supports subtle communication via iconographic messages.

3D

MRS1

Interlink trajectories (with communication and awareness services)

2 x New communication media to connect people (via use of symbolic iconography)

MESSAGE IN A BOTTLE with mobile

- not sending SMS, but really "Flaschenbotschaften" which are predefined -> easily can be accessed on the mobile

LOOK IT with mobile ; similar to "emotions for emotions"

visual and/or acoustic


Toolbox with icons predefined & possible to edit by the users

not for this pair, but in general possible

icons stand for actions

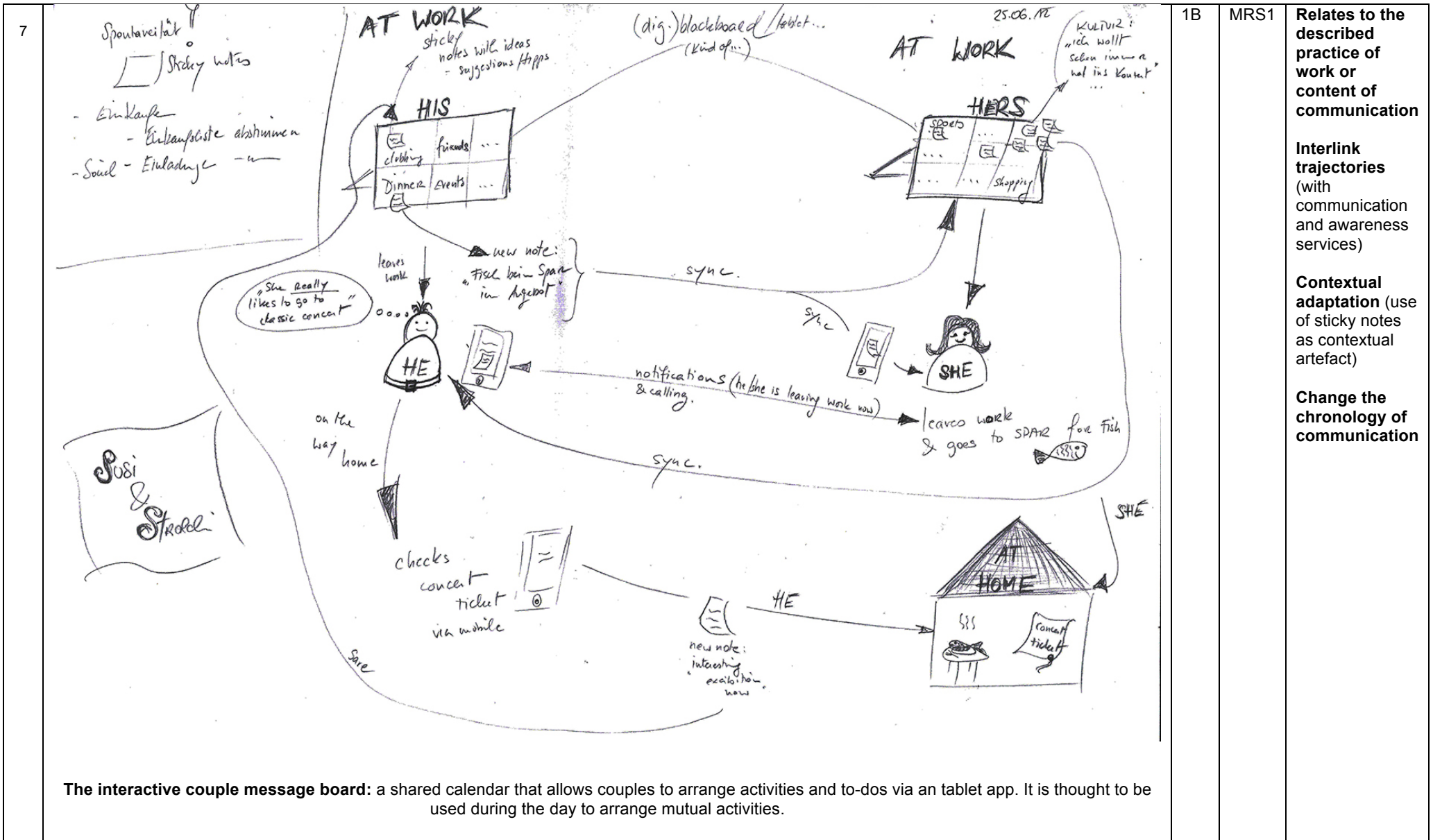
icons have semantic content

e.g. school off: ~~XX~~

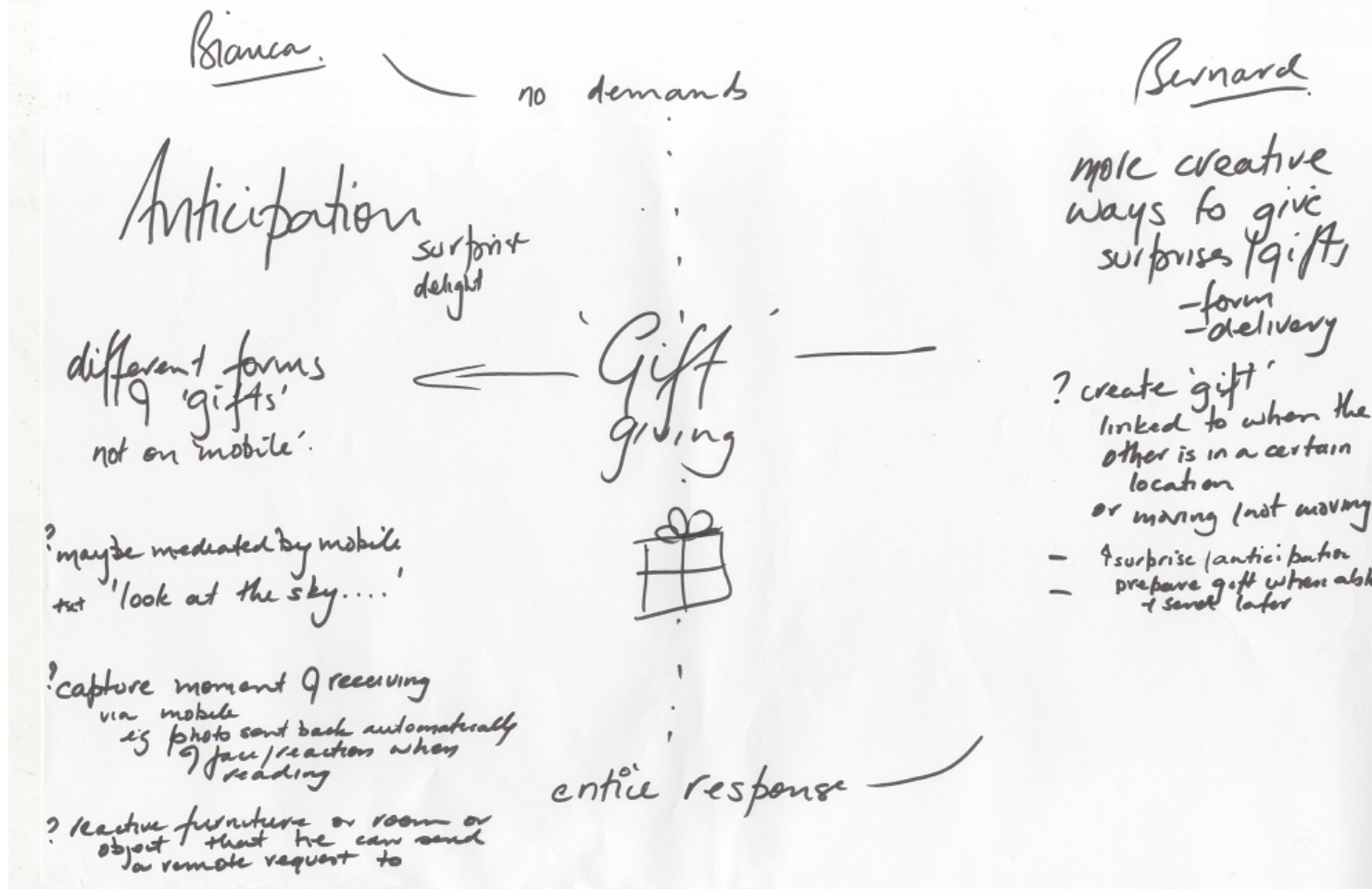
let's go to a restaurant: 



„Icon IT“: App featuring predefined icons that represent actions and emotions. Semantic meaning of icons is only „readable“ for partners.



The interactive couple message board: a shared calendar that allows couples to arrange activities and to-dos via an tablet app. It is thought to be used during the day to arrange mutual activities.



Digital gift giver: Allows couples to send time-tagged and geo-tagged digital presents while separated, e.g. short poems.

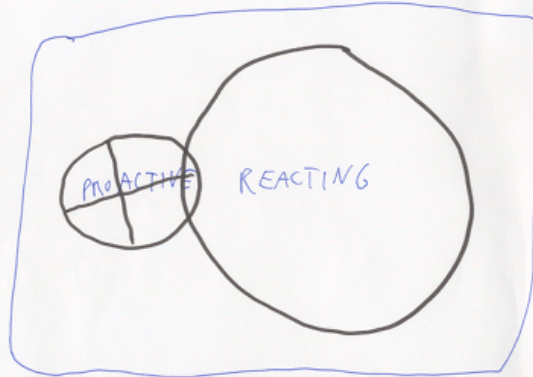
Introduce asynchrony - **change time and location (chronology) of communication** (through digital gift giving)

Contextual adaptation (integration into furniture or device in room)

Relates to the described practice of work or content of communication (gift giving)

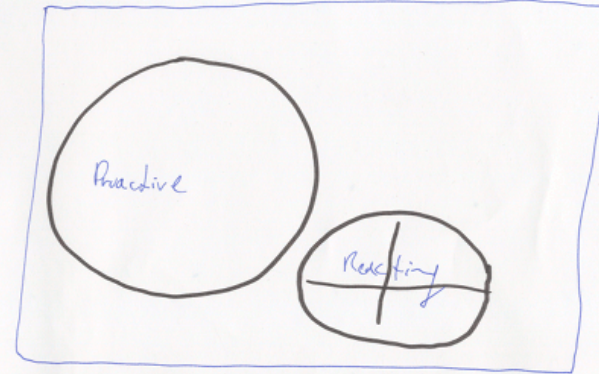
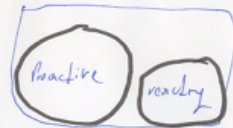
COMMUNICA METER :

Reflecting couples communication patterns overtime



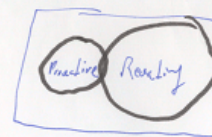
Daisy's view

↓ time passed



Donald's view

↓



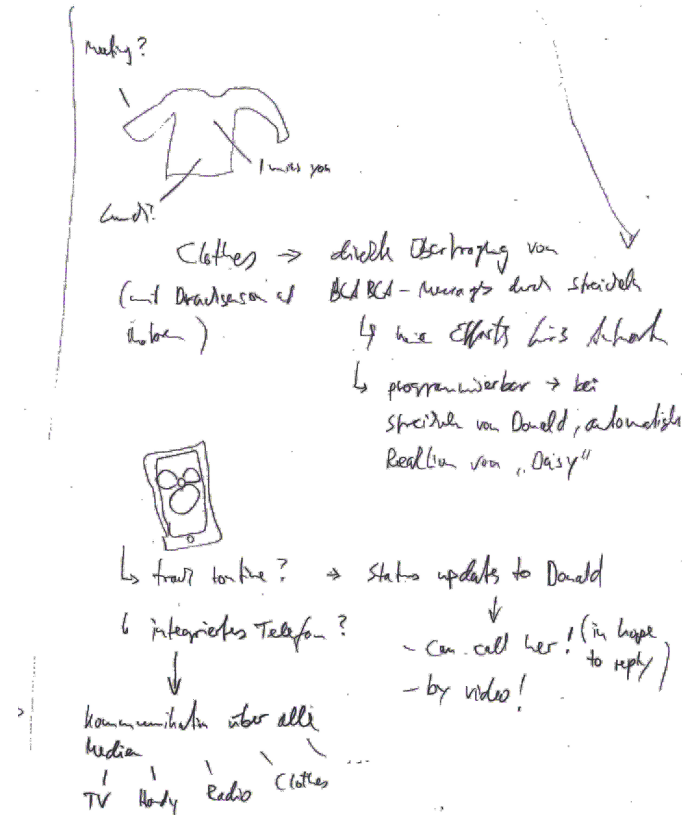
Displays the amount of proactive and reacting communication on personal ambient displays

Communica Meter (Awareness-Builder): Indicates the amount of instigated communication by each partner via an ambient display.

3A

MRS3

Visualisation of communication and awareness building
(visualisation of instigated communication)



Touchy shirt: touching particular parts of an interactive shirt triggers messages to partner, e.g. touching the belly area means „lets have lunch“, touching the heart area „I miss you“, etc.

Contextual adaptation
(integration into t-shirt)

New communication media to connect people
(via use of symbolic iconography)

Ideas to support communication between Daisy and Donald:

① Mood Indicator:

Since Daisy is busy a lot and Donald is often guessing the right time to contact her, he needs some sort of indication to when it is most suitable (best) for him to get a reply. Her current level of stress (state of being busy) could be recorded (eg through bio sensors) or dependent of her location (eg in lecture hall, office, etc).

This information could be displayed for Donald:

- ton/status info in Texting app
- Lamp sitting on his desk (ambient)
- mobile app in general

③ Location-based services:

With LBS the location Daisy could automatically record her whereabouts and assign the levels/states (see ①) to them → also depending on the time of the day (eg in the office she is busy, during lunch breaks she can reply to texts, at home she can call). For display → see ①

⑤ Haptic Texts:

Donald & Daisy send some texts to communicate. This could be made less intrusive and more intuitive through the use of haptic feedback → eg pre-defined vibration patterns, for eg "miss you". The vibrations could be either mediated through their phone or through artefacts that they associate with the other person, eg jewellery. The interaction (sending the feeling) could also be made through jewellery.

~~lamp~~ ~~sensor~~ ~~ambient~~

④ Answering machine for texts:

All text messages that Daisy gets when she is busy are collected and only displayed when she has time for that. Thus, she is not interrupted during work. Donald sees when Daisy has read the text →

⑥ Radio

The music playing in their offices is changing depending on the other's mood and level of occupation

4D

MRS3

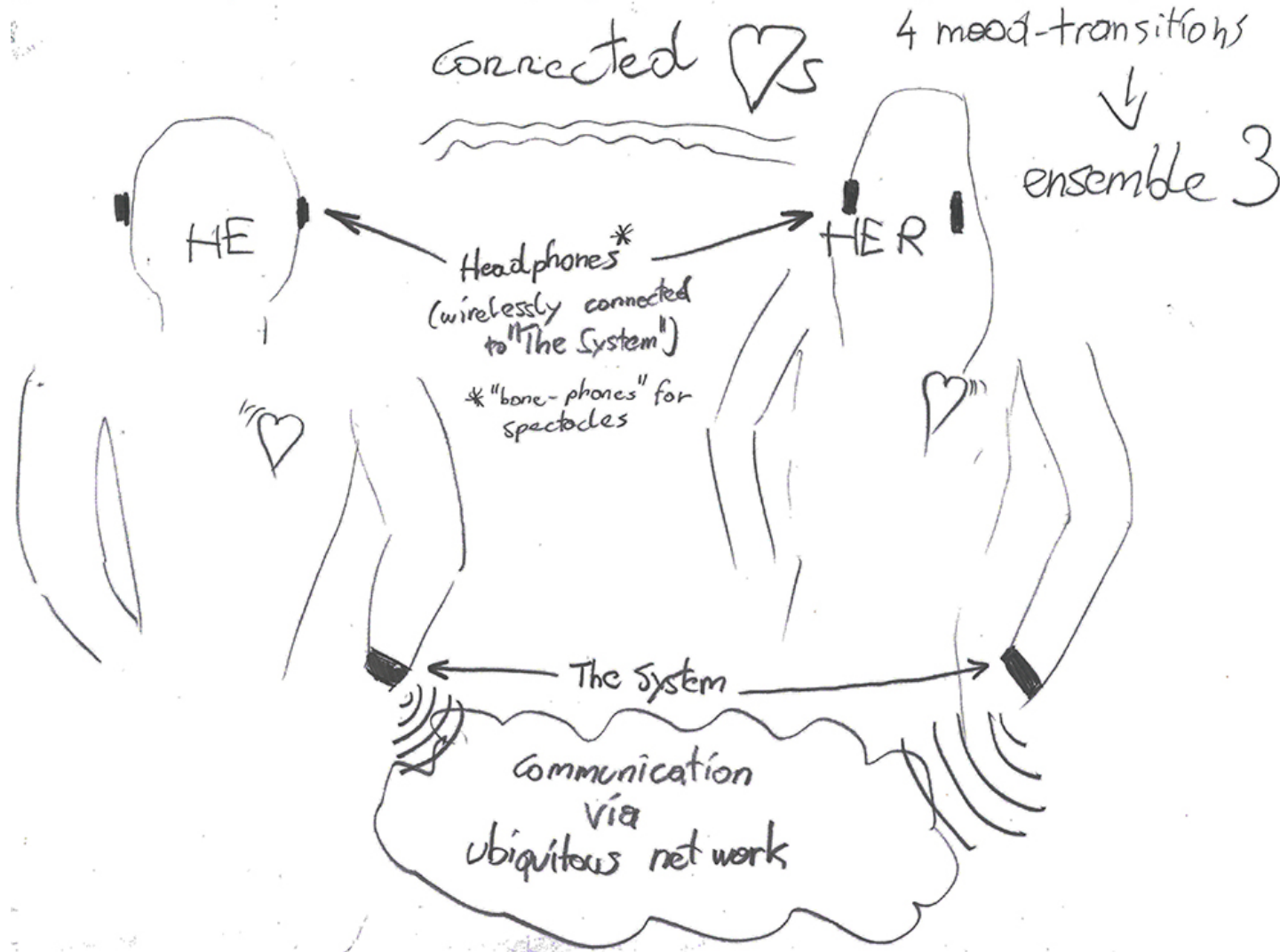
New communication media to connect people (introducing haptic feedback)

Change Chronology of communication (collect and store communication for later, introduce asynchrony)

(3x) Interlink trajectories (with communication and awareness services, indicate stress level of distant person)

Contextual adaptation (integration into jewellery)

(1) **Mood Indicator:** indicate stress-level to partner using sensors, (2) **Location-communicator:** indicate whereabouts to partner, (3) **Haptic-Message exchange** via phones' vibration feature, (4) **Message recorder:** records messages, but pushes them to receiver only when her stress level is low (5) **Mood-Radio:** Ambient sound indicates if/when remote partner is available for a chat.



Connected Hearts: Transmits partners' heartbeats via tactile and auditive interfaces.

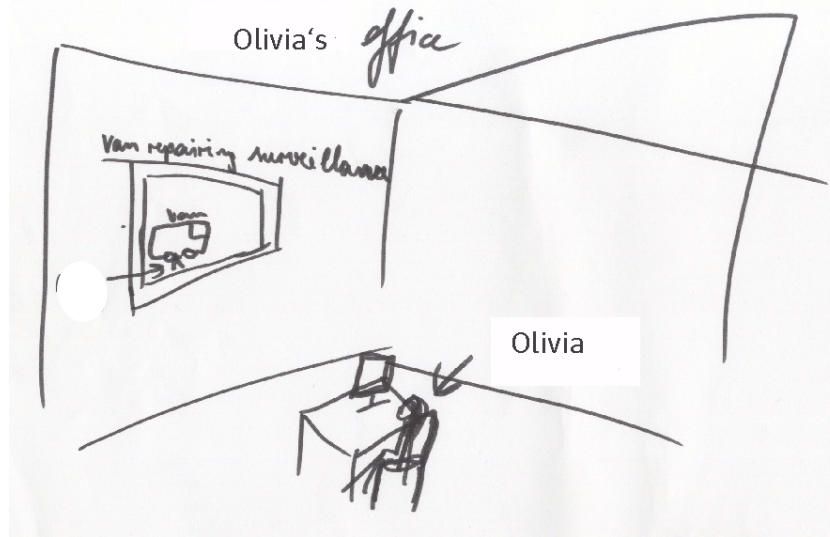
1C

MRS3

Contextual adaptation
(wearable device, body mounted)

New communication media to connect people
(haptic feedback, vibration, heartbeat)

17



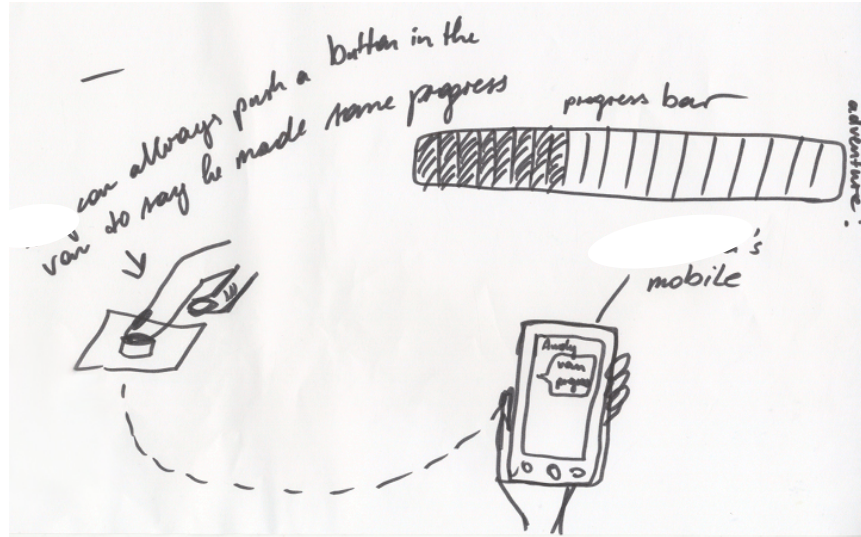
“Project video surveillance app”: Allows one partner to get a glimpse of a situation via mobile cameras that partner places in his current place.

4A

MRS4

New communication media to connect people
(video instead of text and call)

18

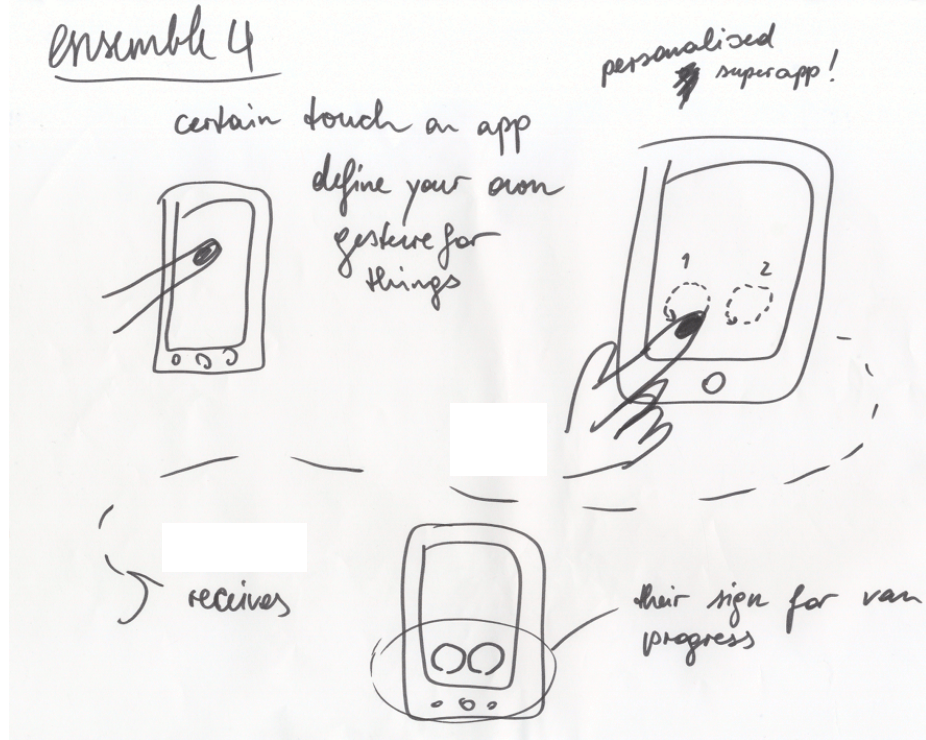


Project progress indicator: Allows indicating the progress of a couple's mutual project by pressing a button that updates a progress bar.

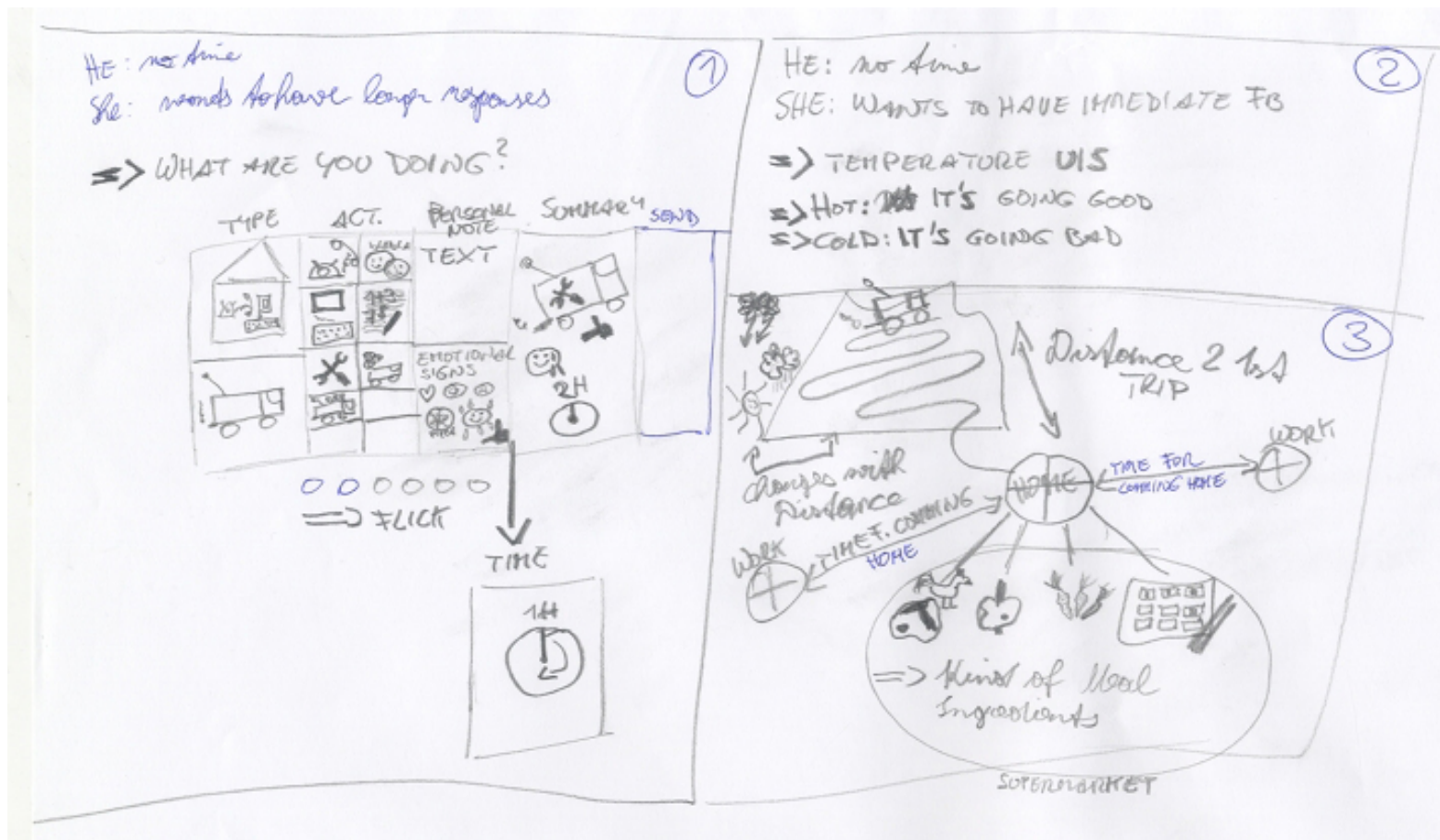
4A

MRS4

Relates to the described practice of work or content of communication



Touch gesture progress app: Allows indicating the progress of a couple's mutual project via self-defined touch gestures.



1D

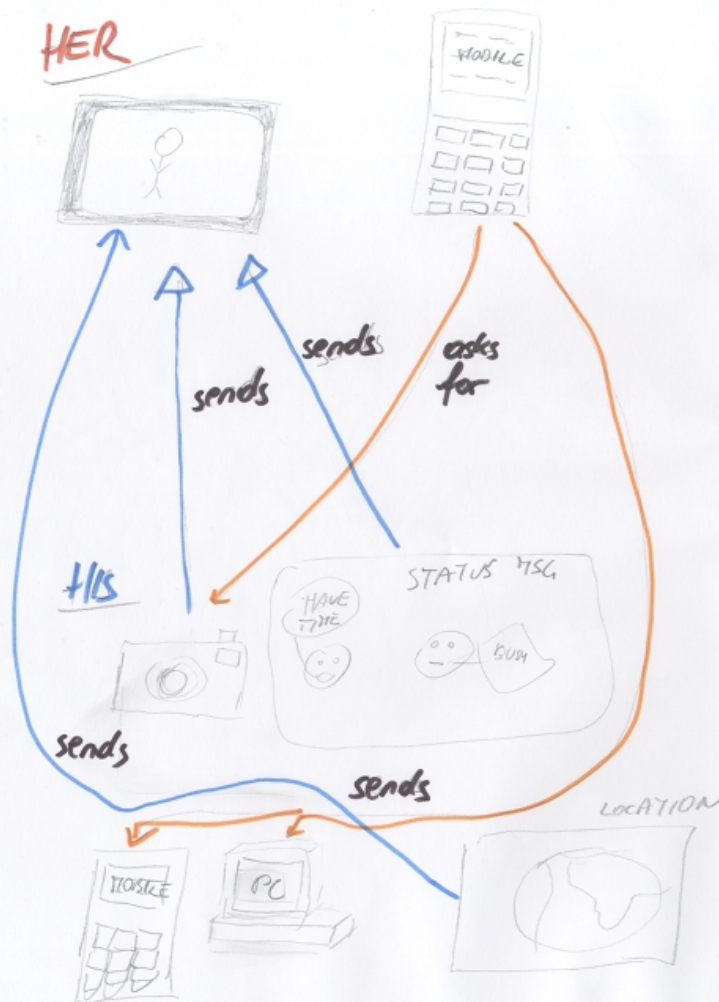
MRS4

New communication media to connect people (address different senses, feeling of being hot/cold; introduction of iconography)

(2x) Interlink trajectories (make aware about other person's context/places and activities)

(with communication and awareness services, indicate other peoples' location)

(1) **What are you doing-icons:** Iconographic messages to indicate activities to partner, (2) **Temperature UI:** Uses a temperature-sensitive user interface to communicate partners' mood, (3) **Distance indicator:** Allows partners to indicate their 'distance to each other' on a space-time diary-like map that is visualised via an app.



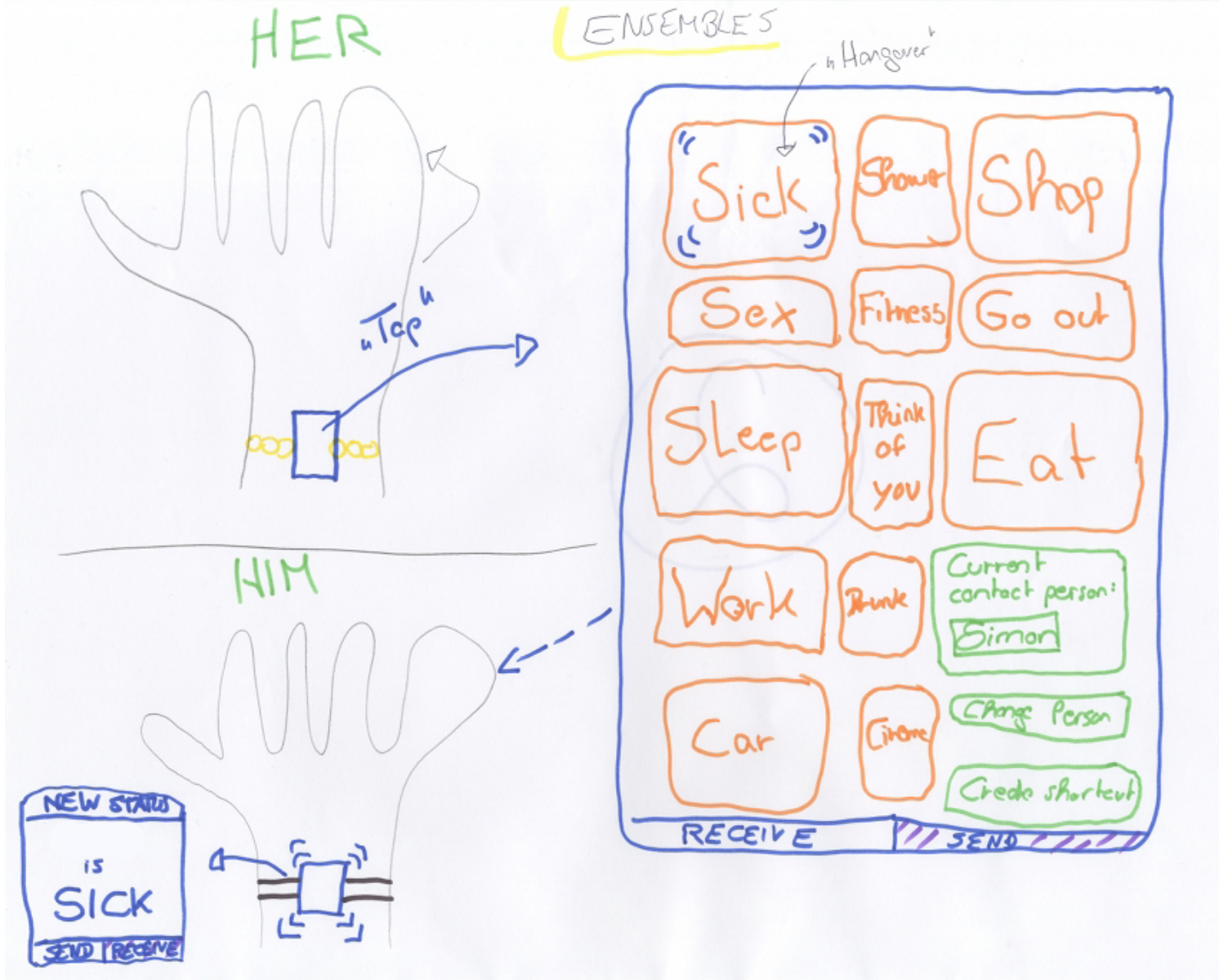
Multi-modal picture frame: Partners can send multi-modal messages including and combining videos, texts and pictures to their partner's picture frame.

ENSAMBLE 4

- NEEDS / REQ**
- multimodal (SMS, EMAIL, PIC, VIDEO, ...)
 - status MSG (busy, available)
 - location info. (where do we meet?)

SOLUTION

- PICTURE FRAME FOR STATUS MSG (his) @^{her} WORKING PLACE
- switch between devices without interrupting the communication process → mainly mail/sms
- extend with picture frame (for ^{her} work)
 - he has a head cam / bracelet / ring for taking pics/videos
 - informing her about tasks
- can she can require pics / long videos from his cam using via SMS
-



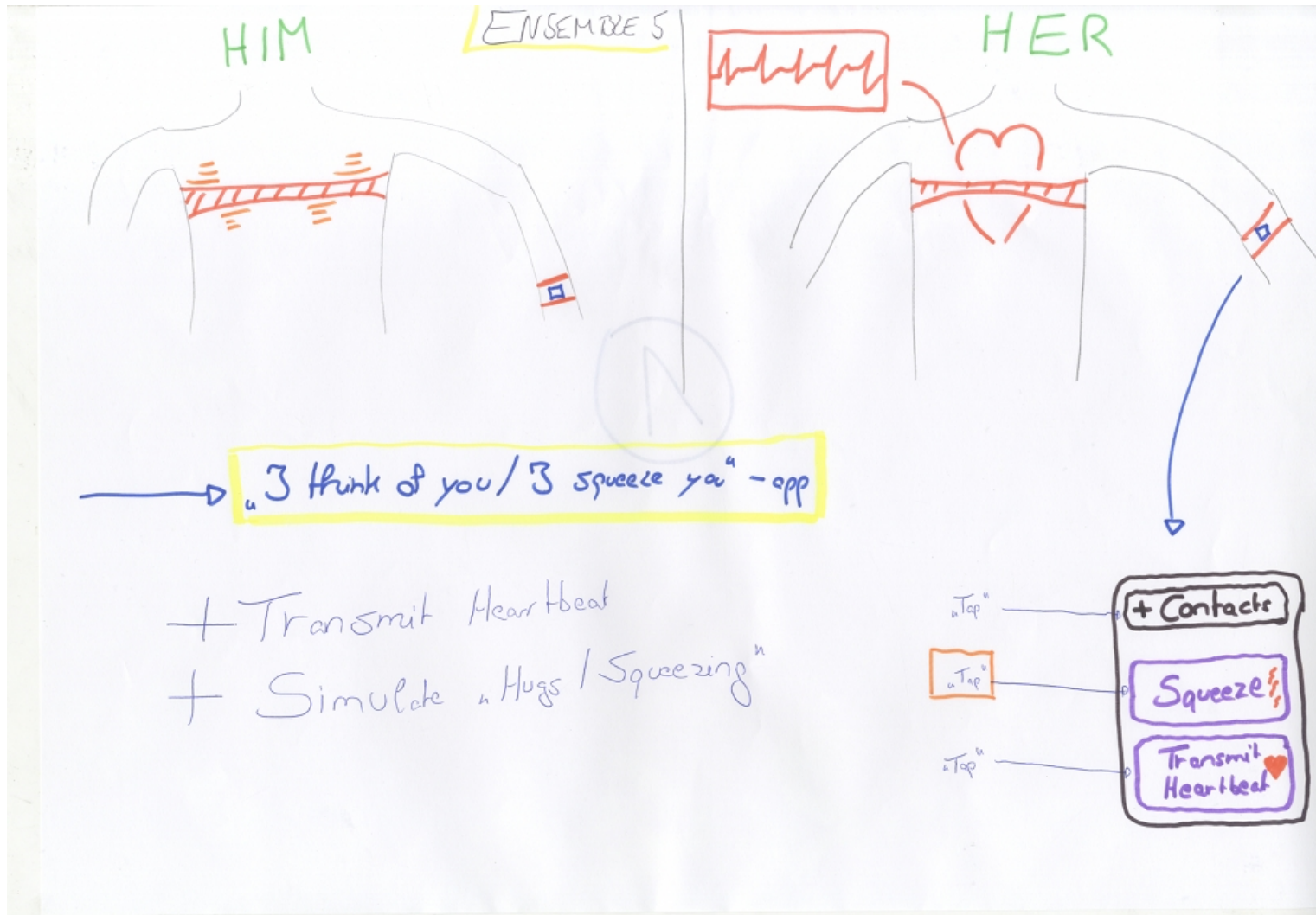
Message wristwatch: a watch-like device that allows to send and receive predefined messages to partner.

C3

MRS5

Contextual adaptation
(wearable device)

Relates to the described practice of work or content of communication
(by providing pre-defined communication content)



Hug-Simulator: Transmits heartbeats and allows to simulate hugs to partner via a chest-mounted sensor/device and an app interface.

Contextual adaptation
(wearable device)

New communication media to connect people
(address different senses, feeling of being hot/cold; introduction of iconography)

PARTNER - MICROBLOGGING

- (-) Smart phone - based (App)
- (-) Fred and Wilma "share" a timeline
- (-) asynchronous communication
 - ↳ Fred does not have to respond immediately
 - ↳ Fred is not interrupted by every single message → he checks the timeline whenever possible
- (-) sending messages is easy
 - ↳ eg. Wilma takes a photo and presses the "Fred" button → others around don't even see that she is contacting Fred
 - ↳ different modalities supported (text, photos, videos, voice, ...)
- (-) answering messages is easy - 2 options:
 - 1. ↳ Fred has enough time and sends a "long" answer (text, video, call, ...)
 - 2. ↳ Fred is busy → but time for a "short" "recognized message" (smiley?)

- (-) App allows "communication" of availability (& mood)
 - ↳ Metadata - Messages ("call me")
- (-) App allows "communication" of importance
 - ↳ Wilma feels how strong Fred shakes his phone
 - ↳ Wilma decides how message is received by Fred (silent, push, vibration, ...)



Partner Microblogging: Microblogging service that allows to indicate availability and importance of messages, which includes short pre-defined messages, and a 'shake-the-phone' receipt confirmation feature.

D2

MRS5

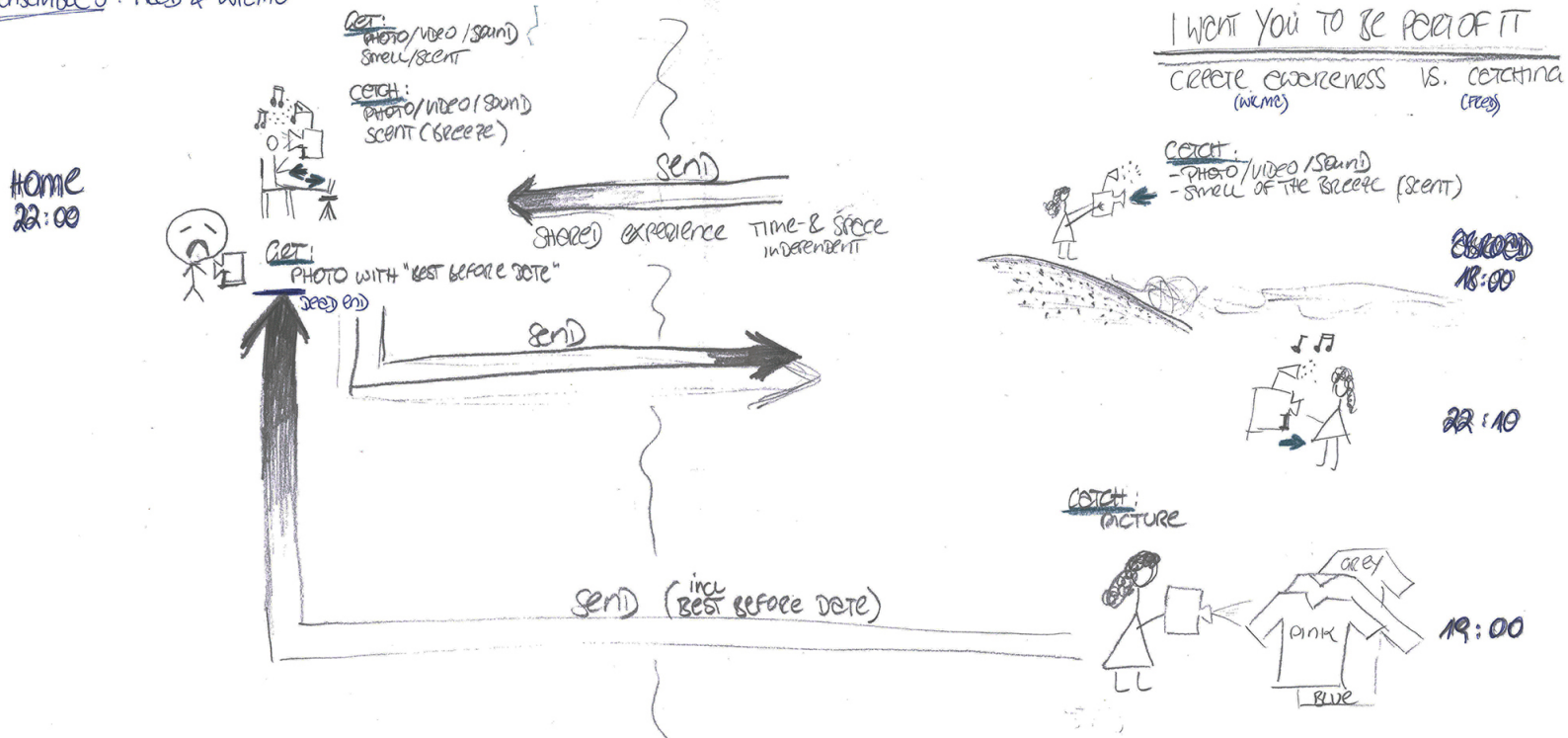
Change Chronology of communication
(by introducing asynchronous communication)

Contextual adaptation
(introducing multimodal communication channels dependent on context)

Interlink trajectories
(making aware about other peoples' context and availability)

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ENSEMBLE 5: FRED & WILMA



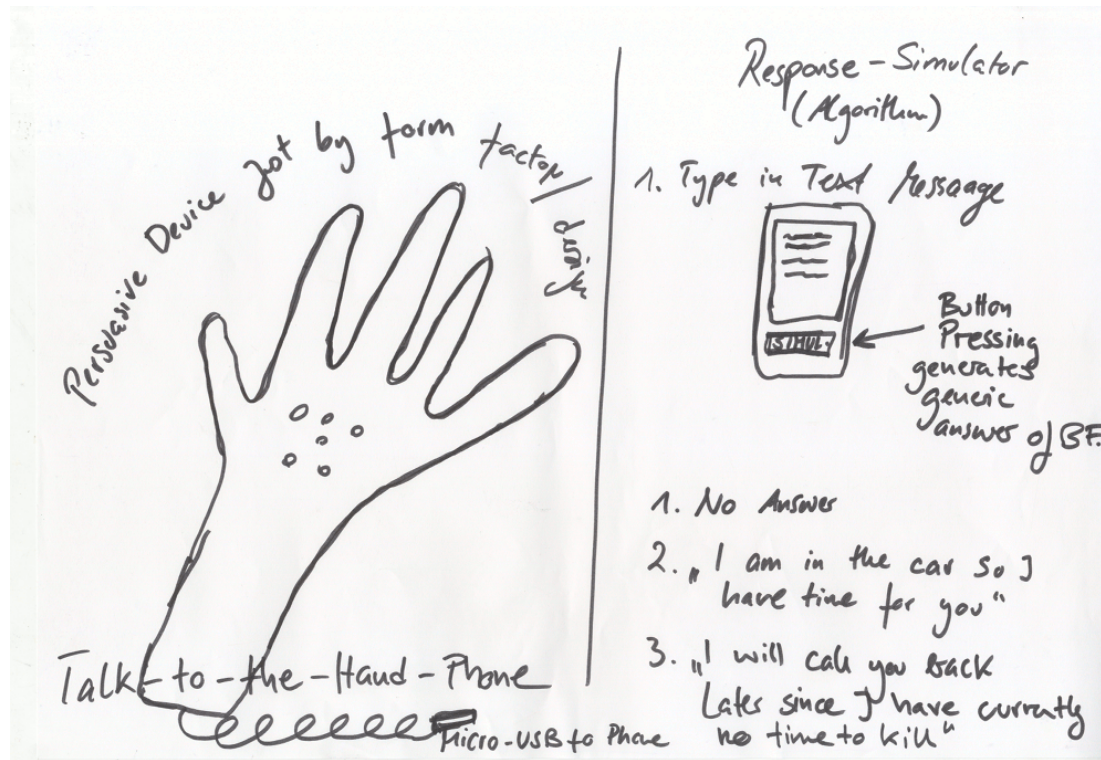
Multi-modal-story-builder: Recording events during the day, one partner can create a multi-media storyline (including a smell interface). The completed story is presented and communicated to the other partner in the evening only.

2B

MRS5

Change Chronology of communication (by introducing asynchronous communication - communication buffer)

New communication media to connect people (introducing smell interface)



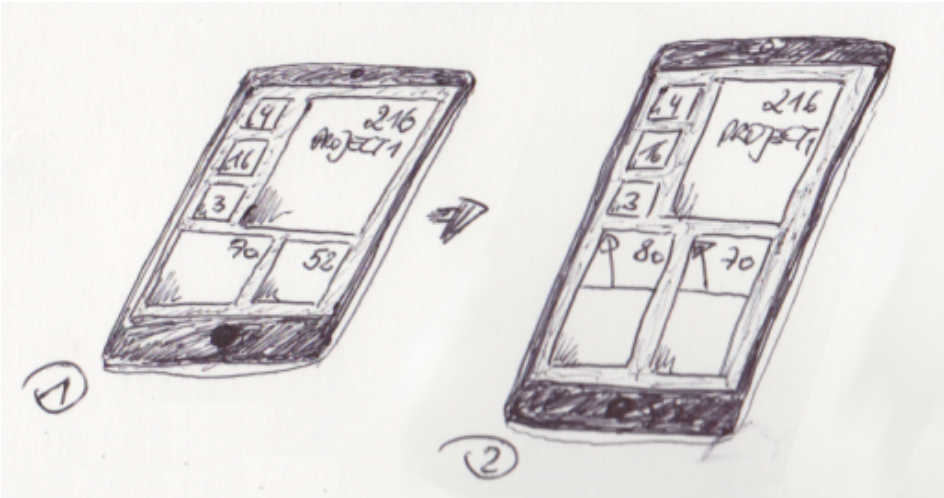
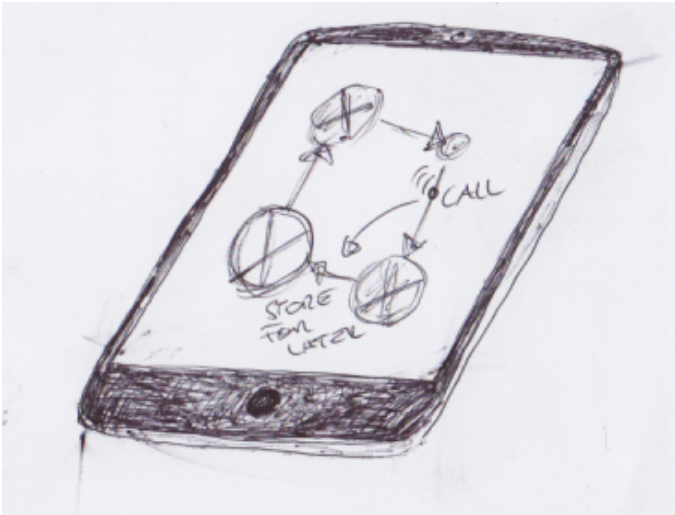
(left) „Talk-to-the-hand-phone“: Hand mounded microphone and speaker with USB connection to phone, (right) **Response-Simulator**: Automatically and randomly generated responses to incoming messages.

5A

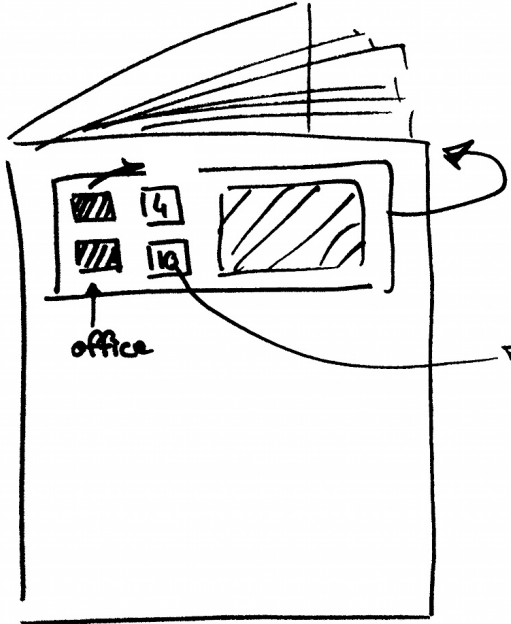
MRS5

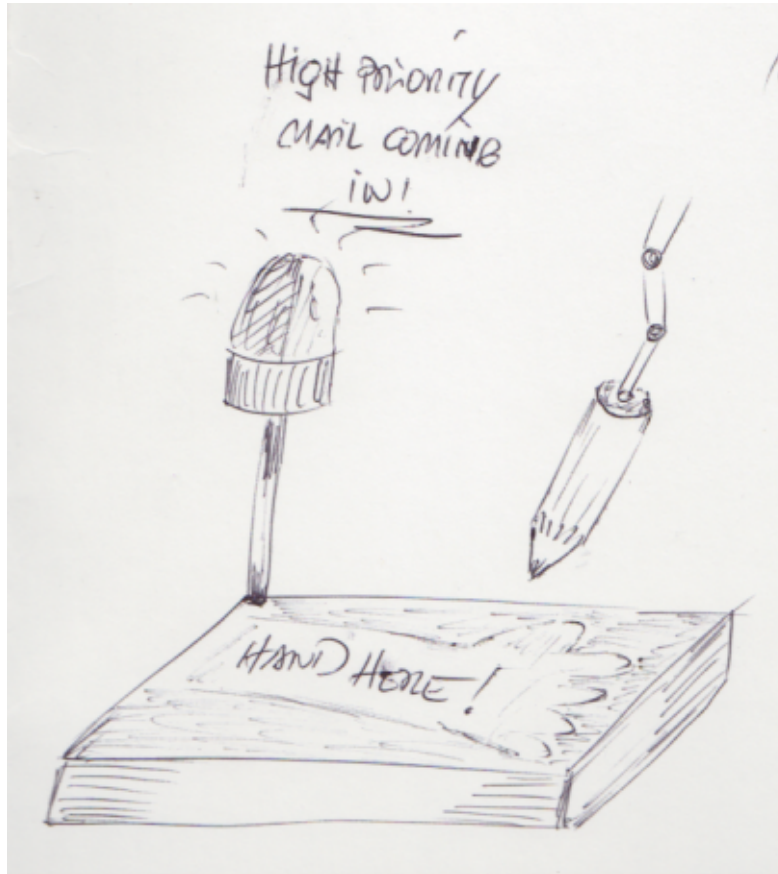
Contextual adaptation
(wearable device on user's hand)

Relates to the described practice of work or content of communication
(by providing pre-defined communication content)

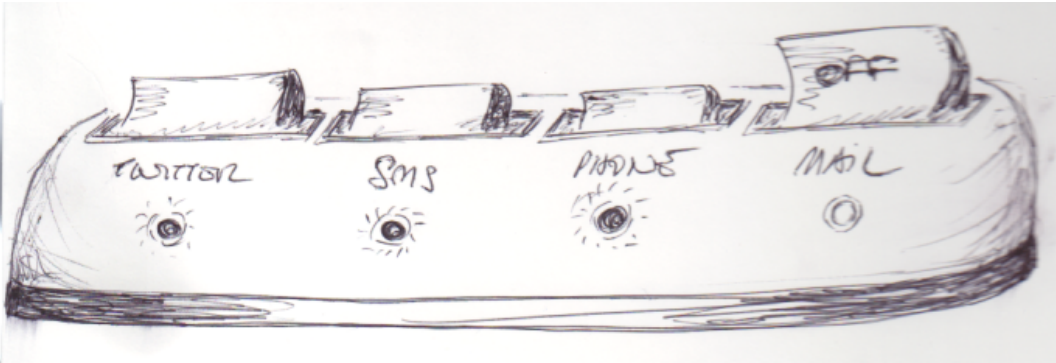
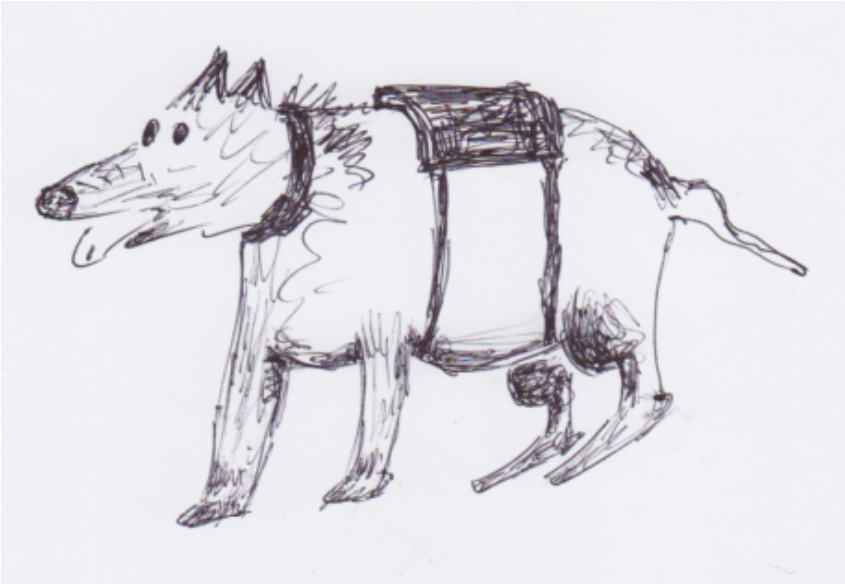
30	 <p>Resizing Inboxes: visual size of inbox indicates the activity in inboxes/projects, e.g. number of incoming messages during the last hour.</p>	Team G	MWC 1	<p>Visualisation of communication and awareness building (resizing visual email inboxes provide visual cues about incoming communication)</p>
31	 <p>Location-based-communication-manager: Allows to geo-tag messages/emails/phone calls and reminders on a tablet space-time-diary-like map.</p>	Team H	MWC 1	<p>Manage the chronology of mediated communication (provide a map that allows relating reminders, emails and calls to specific locations)</p> <p>Change Chronology of communication (helping the user to change time and place of communication)</p>

32	<p>(no sketch available – only verbal description in design workshop)</p> <p>The design concept foresees a system that allows users to generate access-codes. Access codes are needed to reach the user, e.g. to ring or send an email to her, etc. The user can specify specific times/places that require access codes to reach her. Without access-code, calls, emails (etc.) are not put through to the user.</p> <p>Giving access-codes to specific people, the user can manage who can reach her at pre-specified times/places. Other people, who don't have an access-code, cannot reach the user at this time/place.</p>	Team H	MWC 2	<p>Change Chronology of communication (by regulating incoming communication)</p> <p>Manage the chronology of mediated communication (by regulating communication times)</p>
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<p>33</p>	 <p>Email-Activity-Add-On: Little physical devices that can be mounted onto (e.g.) notebooks, which indicate activity/events in an email inbox, e.g. the number of new messages, or incoming messages.</p>	<p>Team F</p>	<p>MWC 2</p>	<p>Contextual adaptation (integration in a notebook that was reported in the Probe)</p> <p>Visualisation of communication and awareness building (by visualising activity in e-mail inboxes)</p>
<p>34</p>	<p>(no sketch available – only verbal description in design workshop)</p> <p>A mobile device service that communicates statistics about each machinery the user looks after. The statistics show positive aspects about the user's work, in contrast to his <i>negative</i> communication with clients, who use to call him to complain. The statistics can be used as a 'communication tool' too. It allows the user to communicate the machinery's performance to clients.</p>	<p>Team F</p>	<p>MWC 3</p>	<p>Relates to the described practice of work or content of communication (providing information about the work task)</p>



Write on the Hand: Devices that writes emails on the receiver's hand (to increase digital communication's pertinence)

36	 <p data-bbox="501 611 1464 639">Availability Switch: Physical device that allows turning digital information channels on/off.</p>	Team G	MWC 5	<p data-bbox="1973 197 2141 304">Contextual adaptation (integration in a switch)</p> <p data-bbox="1973 336 2152 555">Manage the chronology of mediated communication (by regulating communication channels and availability)</p>
37	 <p data-bbox="210 1302 1756 1358">Dog-walker-box: A digital device mounted onto a dog. Dog needs to be walked regularly, which ,forces' user take a break from hectic office work, without being totally disconnected. Users can use the dog-mounted device to access communications while walking the dog.</p>	Team E	MWC 5	<p data-bbox="1973 667 2141 774">Contextual adaptation (mounted on a pet)</p> <p data-bbox="1973 805 2152 1024">Change Chronology of communication (by introducing specific communication and active offline times)</p>

Glossary:

This glossary defines the following terms as they are understood and used in this thesis, they may not necessarily coincide with other definitions in the literature

Annotated space-time diary	A completed space-time diary that is visually annotated by the thesis researcher to highlight the space-time diary's relevant parts for improving its usability and explanatory power in relation to the presented vista of mobile interaction trajectory.
Blended Context:	Is formed out of the locative and mediated context during a moment or period of connectedness.
Completed space-time diary	A space-time diary completed by a Probe respondent.
Completed Probe	The Probe Package as it is returned by the Probe respondent to the thesis researcher. It represents the sum of insights about user and context that the Probe respondent added to the Probe. This includes drawings and stitched on the space-time diary, notes as well as quotes form the debriefing interview.
Context of mobile connectedness:	A person's blended context alongside his/her individual trajectory.
Curated Hankie Probes	A vista of mobile interaction trajectories, expressed via six elements, selected and presented by the thesis researcher: <ul style="list-style-type: none"> - the completed space-time diary on the fabric cloth - a visually annotated version of the space-time highlighting the relevant parts for the vista - a short introduction/summary of the presented vista (text format) - a short description of the Probe respondent (text format) - selected quotes taken from the debriefing interview (text format) - an abstracted and theoretical version of the vista (visual figure)
Design approach:	Is understood as a loosely framed (implicit) procedure promising for potentially achieving desired ends via vaguely defined means in a design process. An approach is associated with a number of user and context focused design resources, but does not pre-scribe their visual and conceptual design, nor their (means of) application.
Design communication	Describes the communication of insights about users and contexts to or in design settings with (or without) design resources.
Design concept	Is an idea for a new product or service, represented by a design sketch, a textual or verbally articulated description. It is understood as the outcome of a generative design process.

Design context:	Represents the broader context in which the generative design process takes place. It comprises ‘everything’ from the client’s wishes, materials, aesthetics to particularities of the production chain and the production lifecycle (etc.) (Krippendorf, 2006).
Design exploration	Is design work with an explorative character, aiming to critique existing or to initialise new topics/materials/approaches/theories of and for design.
Design focused insights about users and contexts	Are insights about user and context, which extent and format for presentation are appropriated to the requirements and needs of a design process.
Design method	In this thesis, a method is understood as a fixed and defined procedure structuring a design process (or user and context focused design research) that promises to achieve desired ends via these predefined means. A <i>method</i> involves a number of pre-defined user and context focused design resources.
Design process	Describes consecutive design work over a period of time to achieve a design outcome, such as problem framing, articulation and forming of design ideas, making, development and evaluation. The design process takes place in (a) unique design setting(s). It is a pragmatic and reflective activity. Designers’ subjective perceptions, background and skills are a relevant factor.
Design resource portfolio	A display of one or more user and context focused design resources (raw and completed), including a theoretical and practical description of its design, scope and application. Represents an agenda for user focused design research via the described resources, communicating the design researcher’s subjective stance.
Design setting	The context in which user and context focused design research and (generative) design processes are carried out, including the available resources for design and the designers’ backgrounds and skills.
Design study	Is used as synonymous for ‘research about design’. In this thesis “design study” refers to the qualitative analysis of design processes.
Design vision	A designer’s first idea about how to respond to insights about users and contexts in form of a statement of <i>what should or can be done</i> , opening up a rough direction for the design process to proceed, not necessarily leading to a design concept. It evolves and changes over the course of a design process.
Design work	Refers to typical design practices for achieving a design outcome over the course of a design process, such as brainstorming, analysing, sketching, making, prototyping, evaluating, etc.

Early front end of design	Refers to early stages of a product or service development process at which ideas, concepts and opportunities for new products and services are formed.
Experience of moments/periods of connectedness	Describes a person's experience of interaction with a distant person or place during a moment/periods of connectedness.
Focus on insights about users and context	A designer's temporary or permanent focus on insights about user(s) and context(s), including and excluding particular insights in the course of the design process (consciously or subconsciously).
Forms to take notes about the contextual situations of communication	Forms printed onto the fabric cloth next to the space-time diary, for Probe respondents to take notes about the context of their communication in each moment of connectedness.
Generative design process	A design process aiming to generate and innovate new products and services inspired and informed by insights about users and contexts. A generative design process starts with the presentation of insights about users and contexts and ends with the articulation of an agreed/satisfactory design concept.
Generative design research	Term coined by Sanders (Sanders, 2005). User and context focused design research informing a generative design process.
Generative design workshops	Is a short-term work assignment for a designer or design team, who are expected to introduce a design concept in response to a design brief in form of a completed Probe that is presented to them.
Generative design work	Refers to typical design activities for achieving a design outcome over the course of a generative design process, designers' insights exploration, brainstorming, story telling, sketching, etc.
Generative mobile interaction design research	Generative design research dedicated to the innovation of new products and services in the field of mobile information and communication technologies.
Handmade Probe	Is a Probe package that makes use of materials and practices of craftsmen and artisans for completing user and context focused design resources: fabric, embroidery, stitching and drawing (or similar materials and practices). They do not make use of commodities like disposable cameras or sketchbooks, nor do they require the expertise of trained craftsmen.
Hankie Probe:	Is a Probe Package, formed out one or more user and context focused design a resource that is supplemented with materials for completion. The core design resource is a fabric cloth showing the space-time diary and forms for contextual note taking. For completion needles, threads

	and a pen are added to the package. Additional material, such as tags that can be pinned onto the cloth, can be added if required by the purpose of the study.
Handmade space-time diary / Handmade Probes	Is the Hankie Probes' space-time diary that has been completed using materials and techniques of craftsmen and artisans, such as fabric, embroidery, stitching and drawing.
Insights about users and contexts	Is everything that is explicitly or implicitly known or assumed about the target user(s) and context(s) of a design process. They are not necessarily a logical and interrelated set of propositions, but can be a loosely related collection of snippets of insights.
Interaction designer	A person trained and working in interaction design (or in a related field), who participates in a design process, who – as part of this thesis research - is presented with one or more curated Probes, asking to respond in Form of a design concept.
Interaction design team	Is a group of interaction designers who participates in a generative design process.
Knowledge regime:	The (provisional) body of knowledge about a specific topic of research, evolving over the stages of thesis research.
Location	A specific position, point, area or region in geographical space, ordered by geographic ordering metrics, e.g. coordinates, or by the build environment.
Locative Context:	The non-mediated characteristics of a location, including social characteristics, objects and products, activities (what people do in this location) and the location's physical aspects, such as sound, light, build environment, etc.
Mediated context:	Contextual characteristics that are physically distant but electronically mediated (in real-time) and present (temporarily) via interactive information and communication devices, e.g. a person speaking/appearing via video telephony, a text message (etc).
Middle range theory for interaction design:	A middle range theory <i>for</i> design allows for the conceptualisation and framing of design problems and insights for design, in a way that could not be done with holistic, overly general and abstract theories, or with overly specific design solutions or theories. A middle range theory <i>for</i> design aims for a (re)usable perspective to frame, scope and focus insights about users and contexts for design processes.
Mobile connectedness:	A physically mobile person's mediated communication with one or more people across several contexts of everyday life using different means of digital communication media (mobile and fixed phones, text messages, video telephony, social networking sites, etc.), expressed in moments and periods of connectedness.

Mobile interaction design	Describes user focused design research and design processes that are dedicated to the design of products and services in the field of mobile information and communication technologies.
Mobile interaction trajectories	Mobile interaction trajectories is a middle range theory for mobile interaction design that conceptualises insights about users and contexts by focusing on practices and experiences of changing states of connectedness, chronologies of mediated communication and mobile communication routines for a single device user, in relation to his/her physical movement patterns (trajectories), contexts of everyday life and virtual tethering to others.
Mobile interaction trajectory's core aspects	The core theoretical characteristics of the middle range interaction design theory.
Mobilities theory (also called <i>novel mobility theory</i>)	A new mobility theory, which re-defines the concept of 'mobility' taking into account the technological advancements in diverse areas such as transportation and communication technologies.
Mobility theory	Defines the concept of mobility (or a sub-set of mobility) with "logical and interconnected sets of propositions from which empirical uniformities can be derived." (Mertens, 1949).
Moment of connectedness:	A temporary situation in which a person interacts with a distant person or place via information and communication media.
Period of connectedness:	A period in time in a person has several moments of connectedness that may (but necessarily) be semantically related to each other.
Place	A location that has a subjectively experienced identity, influenced by the locative and mediated context.
Places of everyday life	Places that are part of a majority of people's everyday life, such as home, work place or office, supermarkets, restaurants, etc.
Perspectives on users and contexts for mobile interaction design	Researchers' and designers' conceptualisation of (insights about) user and context for a particular mobile interaction design processes into "meaningful units of analysis" (Rodgers, 2004). Can be informed by theories for mobile interaction design.
(A) Probe	A Probe is understood as one or more user and context focused design resources used for collecting and expressing informative and inspirational insights about users and contexts in design settings. It is a designed artefact in itself, aiming to evocatively and creatively engage participants in open subjective self-reporting activities, in a format and media that fits the requirements of respondents and design setting(s).

(A) Probe Package	Is a collection of user and context focused design resources that form one Probe.
Practice of moments/period of connectedness:	Describes a person's particular use (or use strategy) of an information and communication device for connecting to or communicating with distant people or places.
Practice-led design research	User and context focused design research that informs design processes conducted in real and context driven design settings, e.g. commercial design settings.
Probing	Probing is understood as user and context focused design research approach that uses Probe packages for gathering insights in collaboration with Probe respondents to communicate them to designers. Insights about users and contexts are consequently used to inform and inspire design processes. Probing is understood as an approach guided by the competence of user focused design researchers.
Probing experiment.	Is a generative design process that seeks to introduce design concepts for new products and services in design settings. It involves the collection of insights about users and contexts via Probes and feeds these insights into design workshops with a number of designers, who respond to the Probes in form of a design concept.
Programme	Documents the 'knowledge regime' over the course of the research. It is understood as one (or more) programmatic statement(s) that form(s) a provisional knowledge regime (Binder and Redström, 2006). It represents the current state of knowledge about a topic of research. It can incorporate critique or describe the current view and the research motivation. It can articulate preferred research practices too. A programme is a (sort of) manifesto, which does not necessarily incorporate research questions. The programme acts as a conjecture, which is distinct from a scientific hypothesis.
Programmatic statements	Individual statements that form the research programme.
Programmatic research strands	Defines a subset of programmatic statements that are related to the same sub-topic of thesis research.
Programme version	Is the programme related to a specific stage of thesis research.
Physical mobility	A person's corporeal movement in-between and across contexts of everyday life.
Raw Probe	The Probe before it is handed over to Probe respondents and completed by them.
Research about design.	Researches the nature and activity of designing, design work or design processes. Design is the object of study.

Research for design:	Research producing knowledge about the field of design, explaining or improving design as a field, e.g. a new design approach or knowledge about a design resource.
Research through design:	Is a type of research that achieves insights and generates new knowledge via design work, design processes using the skill-set of a designer.
Space-time diary:	Allows to visually express everyday trajectories via an abstract map. The map's core entities are circles, which stand for places. Probe Respondents choose circle to indicate the places they are in or go to, e.g. "home", "work", and how they move in-between these places. By connecting the places they indicate their daily trajectories and create a personal map of their everyday physical mobility. Nested places (expressed by lines dividing circles) are used to indicate substructures of a place, e.g. rooms.
Snippets of insights about users and contexts	Are individual instances of insights about user and context, e.g. one particular quote, one particular drawing, etc.
Stages of thesis research	Defined periods of research over the course of the thesis research.
Theory <i>for</i> interaction design	Is a set of interconnected descriptive and explicatory (causal) statements for framing and scoping insights about users and context for design research and design processes into "meaningful units of analysis" (Rodgers, 2004).
Theory of the design process	Describes the uniform characteristics of a design process. Varying theories of the design process exist, relating to varying design philosophical positions, ranging from design processes understood as rational problem solving activities to design processes understood as reflective action (Dorst 1997).
Thesis researcher	The author of this thesis.
Trajectory	Is understood as a person's individual and corporeally movement structure during a day, crossing several places of everyday life.
User and context focused design research	An activity that informs and supports design processes by providing designers with insights about users and contexts in a design setting.
User and context focused design researcher	A person doing user and context focused design research, hence informing and supporting design processes by providing designers with insights about users and contexts.
User and context focused design resource	Is understood as a research artefact that is used to support and inform design processes by collecting and/or communicating insights about users and contexts in a design setting. A design resource is a designed artefact in itself and uses a particular design for expressing insights.

	The term and its understanding is inspired by Cockton's Working to Choose Framework (W2C) (Cockton, 2006, 2009, 2010).
Virtual mobility:	Virtual communication, e.g. phone calls, text messages, etc. connecting two people or contexts with each other.
Vista of mobile interaction trajectories:	Expresses a real-life example of mobile interaction trajectories. It is a focused narrative presenting a selected theme taken from the completed Probes. The vista is selected and introduced by the thesis researcher and expressed via a curated Hankie Probe.

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- Appendix 4.2: Paper: Leitner M.; Innella, G.; Yauner F.; Different Perceptions of the Design Process in the Context of Designart, in Journal of Design Studies; Volume 34, Issue 4, July 2013, pp. 494—513
- Appendix 4.3: Reflective essay about “the lost notes project”
- Appendix 5.1 Design resource portfolio study 1 mobile relationships
- Appendix 5.2: Design resource portfolio study 2 work communication
- Appendix 5.3: Probe Respondents’ use of the fabric format
- Appendix 5.4: full-scale completed Hankie Probes study 2 work communication
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- Appendix 8.1: Analysis and clustering

Bibliography

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