Research Article

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Using Probes for Sharing (Tacit) Knowing in Participatory Design: Facilitating Perspective Making and Perspective Taking

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Abstract: The sharing of expertise and tacit knowing is one of the core objectives in participatory design projects. This paper focuses on the role of probes for sharing users' tacit knowing. We will introduce the concept of “boundary objects” [22, 21] to analyse how probes facilitate perspective taking and perspective making between users and between users and researchers. In so doing, we demonstrate that probes can facilitate the sharing of users' tacit knowing and expertise (i) by making and explicating individual users' perspectives, (ii) by enabling participants to take each other's perspective and make a joint perspective and (iii) by subsequently enabling the making of a joint vision on the digital design outcome. The research presented in this paper is based on an EU-funded research and innovation project in which we co-created digital neighbourhood guide with older adults. We report from our fieldwork in city 1, where we used probes as part of our participatory design practice.

Keywords: probes, older adults, senior citizens, co-creation, participatory design, expertise, tacit knowledge, neighbourhood, boundary objects

1 Introduction

The objectives of participatory design approaches include moral as well as pragmatic considerations: (i) the sharing of control with users; (ii) the sharing of expertise and (iii) individual, organisational and technological change

[24, 1]. In this paper, we are interested in the second consideration: the sharing of expertise. It is said to increase the chances of a successful design outcome by taking into account users' perspectives and preferences on the activities that the design is meant to support and/or transform ([6], 243). In addition, early user participation facilitates the implementation of design results ([5], 426). Bjögvins-son et al. [1] argue that it is important to make participants' “tacit knowledge” available to the design process and “not just their [the participants'] formal and explicit competencies, but those practical and diverse skills that are fundamental to the making of things as *objects* or *artifacts*” (ibid, emphasis in original).

In this paper, we want to describe and discuss probes as a tool for sharing users' tacit knowing in participatory design. Originally referred to as “cultural probes” this method was used in design contexts in which users were the subject of design interventions (rather than partners or participants) [19]. Probes are self-documentation materials that are handed out to future users with the task of documenting their everyday or aspects of it. The intention of using probes is literally to send a probe into the everyday life of people in order to collect information. Probes can take a variety of forms from diaries, to cameras to maps or games. Usually they are sent to users with little guidance, completed individually and then returned to the designers/researchers. Initially probes were developed to allow designers to find inspiration in the users' reactions to their ideas ([20], 9).

In the following, we want to describe how we used probes in a participatory design context and discuss in how far they can facilitate the articulation of users' knowledge and facilitate the sharing of expertise amongst users and between users and researchers. We will draw on theoretical concepts developed in the areas of knowledge management and information systems research to study (knowledge) collaboration in multidisciplinary teams, and also software development projects (e.g. [4, 10, 16]). In this paper we will draw on this literature, in particular the idea of “perspective making” and “perspective taking” [4] in order develop some themes for how knowledge may

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be shared and expertise assigned in participatory design projects. We will introduce the concept of “boundary objects” [22, 21] to analyse how probes facilitate perspective taking and perspective making. In doing so we show how probes can facilitate the sharing of users’ tacit knowing and expertise. As such boundary objects were developed as a theoretical concept by Star and Griesemer [22] to describe how collaborative and collective work across social worlds is made possible. These objects can be used across communities or work domains because they are “plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites” (p. 393). In use these objects become strongly structured and differentiated through work practices, yet they remain recognisable to the different worlds. The subsequent focus of studies lies on the creation and management of boundary objects as this is seen to be a key process in “developing and maintaining coherence across intersecting social worlds” (p. 393). Participatory design projects are a great example in which different social worlds intersect. The concept has been widely adopted in a variety of disciplines (e. g. relevant ones for this paper include human-computer interaction, organisation studies, information systems research).

The research presented in this paper is based on the EU-funded research and innovation project MobileAge in which we co-created digital public services with older adults. The aim is to make these services as useful and meaningful as possible. In so doing, we take a situated-practice based approach when defining, designing and implementing services for an ageing population. This approach to co-creation is grounded in the everyday life of older adults, their needs and interests as well as available resources. In this paper, we report and reflect on the field work conducted in one of the co-creation sites: [field site 1], Germany.

In the following, we introduce considerations about what we understand expertise to be and how this may be useful for understanding collaboration and knowledge sharing in participatory design contexts. Subsequently, we review HCI literature on probes, in particular with respect to its concepts of expertise and interpretation. Then we will analyse our empirical material, asking how the probes helped participants to share their knowledge and thereby produce a joint perspective on the problem focus of the participatory design process and its design outcomes. Finally, we propose that the concept of boundary objects is a fruitful way for considering further the power of probes for sharing users’ expertise.

2 Theoretical Framework

2.1 Probes

Probes were originally conceived by a group of researchers/designers within an EU-funded project to engage with older adults [11]: The cultural probes – a pack of maps, postcards, a camera, a photo album and media diary – “were designed to provoke inspirational responses from elderly people in diverse communities” (p. 22). Gaver et al. conceived of them as something like astronomic or surgical probes, which are left behind when researchers leave and over time return fragmentary data. The probes were part of an experimental design, in which a group of researchers wanted to find new ways for developing projects for unfamiliar groups. “Understanding the local cultures was necessary so that our designs wouldn’t seem irrelevant or arrogant, but we didn’t want the groups to constrain our designs unduly by focusing on needs or desires they already understood” (p. 22). In contrast to scientific probes, cultural probes were meant to be a source for inspiration, not information. It aimed to be surprising and creative.

In subsequent years, probes became widely adopted in human-centred and participatory design and were amended to include concepts such as “design probes” [15], “technology probes” [13] or “mobile probes” [12]. For Boehner et al. probes are different from other social research methods as they embrace uncertainty and ambiguity and therefor invite interpretations by designers and participants: “They aim to open up possibilities, rather than converging towards singular truths, and can be understood as part of a conversation among designers and the people and places for which they design” ([2], 185).

One way in which probes came to be appropriated was as a tool for data collection. Most studies, as Boehner et al. [3] point out in their review, adopt probes as part of their initial investigation for understanding a particular context. Often they are coupled with interviews and at times supplement ethnographic approaches. Some studies integrate probes in participatory design exercises; for example, discuss the results of probes with participants. In general, probes are either used to understand current use situations or to get ideas on new applications.

Some studies take the participatory aspects of probes further and insist that participants should also be involved in the translation of the probes into design ideas (Maaß & Buchmüller, this issue, [3]). Others see probes as a possibility to allow participants to reflect on their own practices and to express these reflections ([23], [3]). Participants de-

cide and control what information they record and share, and in so doing secure their privacy.

Importantly probes are not an alternative formal or objective method for simply “getting data” but rather “frame an alternative account of knowledge production in HCI design” ([3], 1078). In their review of how HCI researchers have appropriated probes, Boehner et al. [3] suggest that there has been a shift in the definition and interpretation of probes from response to representation: “from seeing interpretation as a researcher *responding to what was expressed by the researched* to seeing interpretation as a *researcher ascertaining facts about the research*” (p. 1082, emphasis in original). The idea of *interpretation as response* understands the process as dialogical in the sense that researchers articulate their research questions and instruments, which are interpreted by the participants. The participants in turn respond by expressing their interpretations; researchers respond by expressing their interpretations through potential design ideas. There is never an attempt to “fix the true meaning of any particular response”. In contrast, the idea of *interpretation as representation* aims to “fix the true meaning of what users said, who they are, what they do, and what they need” (p. 1083). Boehner et al. [3] argue that “a major focus of probes’ uptake in HCI has been to use probe returns to develop objective, factual descriptions of user needs” (ibid).

In this paper, we want to propose a different understanding of the role of interpretation when using probes in participatory design processes: Probes as boundary objects that enable/facilitate the articulation of users’ tacit knowing and the shared interpretation of their accounts. Others have pointed to the ability of probes to act as “boundary objects” (e.g. [1, 7]). What is of particular interest is the focus on collaboration and knowledge sharing across social worlds. In this paper, we want to explore further what this means for the negotiation of expertise, as coordination device between researchers and participants and as a way to articulate tacit knowing and make it accessible to others. How users’ expertise and their tacit knowing may be conceptualised will be described in the subsequent chapter.

2.2 Sharing Tacit Knowing: Perspective Making and Perspective Taking in Participatory Design

As mentioned in the introduction, one of the main reasons for having users participate in design processes is that they bring their expertise into the design process so that a successful design outcome (whatever that may be)

is more likely. In the following, we review some of the key literature on expertise (and tacit knowing), in order to get an understanding of what it is, that participating users are meant to share.

Whereas expertise used to be understood as something logical, the understanding of it has moved towards ideas of expertise as something practical: “something based in what you can do rather than what you can calculate or learn” ([8], 23). Polanyi [18] who coined the term “tacit knowing” has contributed to this understanding. He conceptualised tacit knowing as something highly personal and difficult to communicate: It is embedded in the experiences of individuals (such as the knowledge on how to ride a bike or how to swim) and includes mental models and beliefs. These models and beliefs are often taken-for-granted assumptions about the world. Based on the idea of tacit knowing, Polanyi [18] famously stated: “We can know more than we can tell” (p. 4). Explicit knowledge, in contrast, is defined as articulable and objective; it can be codified, stored in databases and libraries, and ultimately circulate easily. The difference between tacit and explicit knowing may be summarised in the following quote: “The knowledge that I have of my own body differs altogether from the knowledge of its physiology” ([18], 20). Yet, as Polanyi argued these two modes are not separate but constitutive of each other (e.g. my knowledge of the physiology of human bodies will shape the way in which I experience and know my own body and vice versa).

If the tacit knowing of future users is of interest in participatory design processes, in particular beyond the obvious and conscious needs or desires of users, then the question arises how the articulation of this knowledge may be facilitated. One answer may be found in Orlikowski’s [17] account of “material knowing”. Similar to Polanyi who stressed the proximal character of tacit knowing, Orlikowski ([16], 249) argues that knowledge is not something static or a stable disposition, but something that is continuously produced and reproduced in everyday practice. A practice view on knowledge leads us to understand knowing as *emergent* (arising from everyday activities and thus always ‘in the making’), *embodied* (as evident in such notions as tacit knowing and experiential learning), and *embedded* (grounded in the situated sociohistoric contexts of our lives and work). And to this list I want to add another critical dimension, and that is that knowing is also always material ([17], 460, emphasis in original).

Orlikowski [17] argues that “everyday practices and the knowing generated as a result is deeply bound up in the material forms, artifacts, spaces, and infrastructures through which humans act” (ibid). In this paper we argue that the materiality of probes allows participants to act

with them and in so doing perform their knowing. In the same vein Björgvinsson et al. ([1], 105) suggest that one way to think about participatory design is to understand design artifacts, such as mock-ups or prototypes as boundary objects binding different stakeholders together. Star and Griesemer [22] originally described four types of boundary objects which Gasson [10] discusses with respect to software development projects:

- *Repositories*, such as libraries, which allow differences in the unit of analysis used by different groups. Star [21] suggests that repositories come “from the need for an assembly of things that are conceived iteratively” (p. 603). Heterogeneity of the things assembled can be maintained without becoming confrontational. The advantage of a repository is its modularity.
- *Standardised forms*, methods and procedures, which enforce normative work practices across knowledge boundaries and provide a shared format for solving problems. As such, these objects circulate easily and provide a standardised way of collecting information.
- *Models or ideal types*, which provide an abstraction that works for all knowledge domains. It can be a diagram or other description which does not accurately describe any details about any one locality or thing but which is adaptable across sites because of its vagueness. It can hence facilitate communication and cooperation across different sites.
- *Coincident boundaries*, such as a district or country, which provide a common boundaries of analysis while permitting different internal contents. “The result is that work in different sites and with different perspectives can be conducted autonomously while cooperating parties share a common referent” (p. 411).

Star ([21], 603) later refined the concept stating that an object is not just a thing but that its materiality is derived from action. Objects in her concept are “a set of work arrangements that are at once material and processual” (p. 604). Interpretive flexibility grants objects the ability to overcome boundaries, to become “boundary objects”. These objects that are viewed differently, for example by different professions allowing them to communicate. Hence “these common objects form the boundaries between groups through flexibility and shared structure” ([21], 603). The term boundary is not meant to divide between two groups but rather signifies the shared space in which they meet. They form boundaries between groups through flexibility and shared structure.

Star’s and Griesemer’s interest was on the ways in which boundary objects enable collaboration between dif-

ferent actor groups. In the knowledge management literature, scholars were more interested in whether and how knowledge may be shared across different groups of experts or communities of practice. For example, one of the big challenges in any software development project is the coordination of expertise. In this respect it is important to consider the aggregation and coordination of individual expertise ([9], 1555). Boland and Tenkasi ([4], 356) suggest that boundary objects facilitate processes of “perspective making” and “perspective taking”. Perspective making describes a process in which a community specifies and refines its knowledge domains and related practices. Through this process, communities are able to collate and align their perspectives and thereby develop common meaning structures (ibid). Boland and Tenkasi describe perspective making as a social practice, often based on narratives of experience and grounded in reflexivity. Ultimately, perspective making leads to some form of representation which explicates the knowledge (e. g. in form of boundary objects).

Perspective taking, in turn, starts with an understanding of what others know and requires an interpretive reading of the accounts that others have given.

For perspective taking we need a shift in emphasis, to focus on the individual’s ability to make his or her own understanding visible for self-reflection. Once a visible representation of an individual’s knowledge is made available for analysis and communication, it becomes a boundary object and provides a basis for perspective taking ([4], 362).

One example that Boland and Tenkasi provide is that of a map: a cause map depicting a physician’s understanding of quality in medical care. By drawing the map, the physician makes his or her perspective visible (possibly even for him or herself). The map can then be exchanged with other physicians in different departments of the hospital. As such this map (or boundary object) allows for perspective taking across different communities of knowing (p. 362). Below is Figure 1 from Boland and Tenkasi [4] that explains their concept of perspective making and perspective taking.

We will now proceed to present a participatory design and research project with older adults in which we used probes to explore and learn about the everyday lives of older adults in [district 1] in a structured and reflective way, but also to establish our participants as experts of their district and of ageing in this place. In particular, we analyse to what extent the probes served as boundary objects among users and between users and researchers, and how they facilitated individual and communal perspective making and perspective taking.

Figure 1: Perspective Making and Perspective Taking [4].

3 Case Study Methodology

While new information and communication technologies, in particular mobile applications offer great potential for effective and improved (digital) public services, they do not seem to be the appropriate delivery channel for older citizens as there remains a gap in access to online services between younger and older adults. Part of the reason for a remaining disadvantage of older adults in accessing online services is in the design and delivery of these services. In MobileAge, we develop and evaluate a co-creation methodology to address this challenge. By jointly developing digital public services with and for older citizens, the aim is to make these services as useful and meaningful as possible. In so doing, we take a situated-practice based approach when defining, designing and implementing services with and for an ageing population. This approach to co-creation is grounded in the everyday life of older adults, their needs as well as available resources. In this paper, we are reporting of the fieldwork conducted in one of the co-creation sites: [city 1], Germany.

The focus of the co-creation activities in [city 1] was on the socio-spatial aspects of social inclusion: This is a pertinent topic as the relationship and bond with their immediate living environment as well as the capability to move within their neighbourhood confidently become more and more important as people grow older. At the same time, there is an increased risk of loneliness as relatives and friends may pass away. Thus, older adults are in need to

find places and opportunities for social interaction and civic participation which is strongly related to their confidence of moving freely within their neighbourhood. Dimensions to be considered about the socio-spatial dimension of social inclusion are older citizens' (1) sense of attachment and social connection: knowing a neighbourhood, (2) their sense of security and familiarity: knowing where to find relevant information and resources and (3) their sense of identity, linked to independence and autonomy: e. g. knowing where organisations and places are located, which services are provided, and how to access them [25]. The fieldwork was divided in two co-creation interventions in two districts: district 1 (May 2016 – January 2017) and district 2 (April 2017 – December 2017). Here we only report about district 1.

District 1 is characterised by six very diverse neighbourhoods that give the district its multifaceted character. The neighbourhoods are important points of reference for the identity and even moving of many people. In May 2016, we began our co-creation process by recruiting 12 older adults living in the district. Their age ranged from 55 to 80, their use of digital media ranged from a non-user to very proficient users; two participants were still working. As one of the first activities, we invited our participants to document (and self-report on) their movement and their primary social networks in the district by using probes. The service idea that was developed, refined and implemented throughout the co-creation process was a digital, interactive neighbourhood guide. In the following, we will present examples of these probes and discuss in what ways they helped participants to explicate their tacit knowing, to develop a joint perspective on their district, and on what it means to grow older in this district. Eventually probes allowed participants' to explore and develop a service idea (see also [14]).

In total 11 probes bags were returned. The bags contained a diary for the documentation of everyday practices as well as biographical and personal information, postcards with reflection tasks concerning technology, the past and the future (of the district), a disposable camera and a map of the district with dots to mark places of relevance. Following the return, we conducted individual interviews with each of the participants. These interviews lasted about 90 minutes. All interviews were voice recorded and transcribed. In a subsequent workshop, the participants jointly reflected on the activity and interpreted the probes. Part of the workshop was recorded and transcribed, notes and photographs were taken. We analysed the probes material as well as the interview and workshop transcripts with regard to how the probes facilitated perspective making and perspective taking of and between participants,

and between participants, researchers and software designers.

3.1 Mapping Socio-Spatial Networks: Explicating Perspectives and Demarcating Areas

One probe we gave to participants was a map of the district (figure 2). The main aim of this probe was to understand social inclusion with respect to primary networks and space. Participants were asked to mark where they live (red dot), where friends & family live (blue dots), where important places for their everyday are (yellow dots). In addition, participants were asked to highlight areas they particularly like in green, and areas they dislike in pink.

What we were interested in learning from this map concerned for example how connected our participants felt to people/places and the spatial dimension of their primary networks (neighbourhood, quarter, district, and clubs). We were also interested in learning which social networks the participants were part of and where they meet.

The returned maps differed greatly with respect to the extent of the networks and the mobility patterns. The maps were supplemented with the diaries and a set of seven maps in which participants documented their routes for a week. Not surprisingly we found in the analysis of the district map that the participants' social networks are very much centered around their respective neighbourhoods. Since the participants live in very different neighbourhoods their social interactions take place in different areas of the district. Preferences for certain areas as well as aversion regarding others also differ with regard to their primary networks.

Figures 3 and 4 are two cutouts from the maps of two participants. They both comprise of the same area. Yet, where participant 5 (figure 3) has highlighted an area in pink (signalling that this is an area she does not like), participant 10 (figure 4) marked the area with a blue and yellow dot (important places) and highlighted an area close-by in green (areas participants like). In the interview, participant 10 explained that this is where she walks her dog. Again, the participants lived in different neighbourhoods and hence had very different mobility patterns and relations in and to the area.

Later on, such conflicting perspectives became a rich resource for discussion, when determining which places would be included as “nice places” in our district guide.

Another difference in marking locations on the map was based on the different practices of people and what associations they had with particular places. For example, while a number of participants marked the big cemetery as an area in which they liked to spend time, one participant only marked it as place she routinely visits because of the graves she has to attend to (figures 5–7). The places were hence associated with the practices in which people engage and through these practices became part of the socio-spatial network.

Finally, many participants marked similar places in the district as reference to where they routinely go (figure 8). Yet even here, we find differences with respect to whether these were also considered or known as recreational places.

These initial findings were further explored in individual interviews with the participants. Talking about the maps and the mappings in the interviews encouraged almost all participants to reflect on the district as a whole, its multifaceted character and its image. Here we found that the spatial separation depicted in the maps corresponded with a stereotypical and often negative attitude towards other neighbourhoods. In particular two neighbourhoods, one characterised by tower blocks and widely known as socially diverse and troubled area

Figure 2: Probe – district map.

Figure 3: Cutout of map participant 5.

Figure 4: Cutout of map participant 10.

Figure 5: Cutout of map participant 5.

Figure 6: Cutout of map participant 7.

Figure 7: Cutout of map participant 3.

Figure 8: Cut-out of the same part of the map from different participants.

(Neighbourhood A), the other one with a rural character and detached houses (Neighbourhood B), are important points of identification and demarcation for the residents. As participant 1 who lives in Neighbourhood B explains:

Yeah, my own neighbourhood, I like that one. [...] I wouldn't like to live in neighbourhood A for example. [...] I'd rather be in the area where I live now or I prefer this. It's kind of like that, a little bit closed off and you know a lot of people and there's a lot of greenery and gardens. Whereas in this tower block neighbourhood, that doesn't suit me at all, I don't like that. I don't want to say that it is terrible, but for me personally, if I had an apartment there, I think I would be truly unhappy. Those tall houses, that overwhelms me. At least to live there. And I never actually go there. If we go on excursions, all right, then we go here to the dike [points to dike on the map] or, if we say "come let's go for a little walk in the evening", then we move around the clinic park, which is also very nice, because it's a lot of greenery and some nice old buildings and if you walk around there for an hour, then you have a little bit of time off your mind.

Participant 7 who also lives in Neighbourhood B, had a more nuanced view on Neighbourhood A. He praised the success of social urban development actions and said that he had "learned to appreciate" the area since there had been renovations that "have made Neighbourhood A somehow attractive". However, he mentioned the neighbourhood only when asked why he had not marked any areas that he did not like in the map. Seemingly his assumption was that we've had this specific neighbourhood in mind when asking for disliked areas. Further, he confirmed that there are prejudices amongst his neighbours:

Nevertheless, it is the case that as Neighbourhood B you actually avoid Neighbourhood A. Because there were also incidents that young gangs somehow attacked people in the early evening hours or something like that.

The map was hence not a mere representation of the participants' place-making practices and tacit knowing of the

district *but also a performance of what they considered to be socially acceptable*, e. g. to mark Neighbourhood A negatively or not.

In contrast, participant 9 who lives in Neighbourhood A produced a very different image of her neighbourhood. She had lived there for a very long time and had “always found it exciting, always interesting”. She told us that

... acquaintances of ours had said that you can't move to Neighbourhood A [...] but I was still unbiased, I thought I'd take a look and now I'm living there and the apartments are really nice and we have a great view from the seventh floor.

She explained that in her opinion the bad image of the neighbourhood was no longer justified today. She had a strong attachment with the neighbourhood and the residents that was rooted in the togetherness of the people living there. She appreciated the ways the residents interact and treat each other, and recounted her negative experiences with neighbours when living in a different neighbourhood for a short while:

The others who owned the condominiums, they were upset that some families had a barbecue. So that was ONE situation, no, that's how it went. And then you really don't feel well. And then other things like that, like bullying and harassment. [...] Something I don't know from here [Neighbourhood A] at all. Because here it's really such a peaceful togetherness and doesn't matter whether one is running around in the pyjamas outside or not. Maybe we smile about it (laughing), but there is no one to blaspheme about such things. That was a little bit there, as I said, it was a little bit different.

Despite these divergent perspectives on the different parts of the district, the participants realised some commonalities regarding preferred and avoided spaces: They differ with respect to the specific areas that they like or dislike (e. g. Figures 3 and 4), but the reasons for these preferences are the same. All of them like to visit calm, green recreational places and they avoid places where young people often meet. Participant 9 explains:

[...] and that's the big parking lot and there are a lot of young people meeting with the car and so on and sometimes it's a bit uncomfortable. I don't really know any really unpleasant places like this. But these are such meeting places for young people, where you just feel insecure and you think they're talking to accost me and stuff like that, yeah.

Participant 5 who differs quite a lot from participant 9 with regard to her socio-spatial networks perceived the same sense of discomfort at places with many young people:

I don't like to go to the lake anymore, because of things that you don't like as an old person anymore, yelling youths and barbe-

Figure 9: Participants discussing their maps during a workshop.

cue sessions, where the rubbish is just left and so on and so on. [...] I don't want to get upset about it. When I was younger, I was able to ignore these things but with increasing age it is strangely more difficult and since I don't want to become a militant old one I choose the avoidance tactic.

Hence, what could be derived from the individual probes and interviews was an appreciation of the participants for green and recreational spaces. Despite differences on where these areas could be found in the district, they all emphasised the importance of green areas. Similarly, we noticed an agreement to avoid places where young people hang out and may intimidate older citizens. These were all individual perspectives that participants made through their engagement with the probes and while reflecting on this exercise during the interviews.

However, it was only during a workshop in which the *participants jointly interpreted the differences in the maps* (which were displayed on a pin board as depicted in Figure 9) that we started to understand some of the reasons for these differences. These interpretations were based on taking their respective perspectives and through interpretation of the assembled maps the participants created a joint, communal perspective.

One of the biggest differences – according to the participants – was whether somebody grew up in the district and still had friends, acquaintances and family from that time or if most members of their social network lived somewhere else. Participants pointed out that this could be seen in particular in the number of blue marks on the map (representing family and friends). A second difference was considered whether somebody still works and also where somebody has worked (as these could have included long commutes with little chance of colleagues living the district). The financial situation was considered as another defining difference (e. g. with respect to buying organic food or owning a house and garden). This makes a difference in terms of shopping behaviour or whether somebody

goes to public parks more often for recreational purposes. Furthermore, the functional health is important with respect to people's mobility in the neighbourhood and beyond. Lastly, it makes a difference whether people are engaged in charity work and if so, where (some people work within in the district, others across the city).

Relating these accounts of our field work back to our theoretical framework, we argue that working with the neighbourhood map facilitated the perspective making and perspective taking of participants in three ways: The neighbourhood maps served (1) as a standardised form and method, (2) as a coincident boundary and (3) as an ideal type.

Standardized forms, methods and procedures enforce a shared view by enforcing particular work practices across participants and provide a shared format for providing input. The neighbourhood map acted as a standardized form by asking people to identify where they lived, where family & friends lived and where important places were. By asking participants to follow this particular procedure when working with the map, it became a standardized form (or method). In so doing, it allowed for the translation of different contexts into the same pattern (colour-coded dots).

The map served also as a *coincident boundary* in that it outlined the demarcation of the district. Through this framing only those activities became visible (and relevant) that took place inside this “coincident boundary”. Many of our participants reflected on this. For example, participant 5 reflected on how she perceived of the district differently when she was still working and commuting to another district in comparison to her reduced mobility patterns within the district since retirement. Participant 7 reflected in the final focus group on how many of his activities took place outside of the district and how much he used the car to get to places. This coincident boundary later became inscribed into the app we co-created with the participants.

Finally, the neighbourhood map facilitated the creation of *ideal types* such as “nice places and walks” as we asked the participants to mark places/areas they like and dislike in the map. There was an initial broad understanding of what a nice area would qualify as. This “ideal type” became more and more refined as the design process progressed. Initially our participants had different ideas and understandings of what qualified as a nice place and also where they might be found in the district. These differences were important for negotiating the future design of the information system. For example, the conversation about the nice places informed the definition of attributes to describe nice places later on in the process (e. g. how to

get there, whether there are benches and toilets, whether there are possibilities to get refreshments).

3.2 Drawing Emblems and Portraying Neighbourhoods: From Demarcation to Diversity – Developing a Joint Perspective on the District

Another item that was included in our probes pack was a disposable camera. Such cameras are a standard probe and we used it in order to “see” the district through our participants' eyes and potentially capture their emotional bond to the district. Participants were asked to take pictures considering the following questions:

“What do you do/where do you usually go? With whom do you speak if...?”

- You feel lonely
- You are upset
- You need help
- You want to relax
- You want to get diversion

Please take pictures of places, people, objects and/or animals.”

Figure 10: Probe – disposable camera.

The pictures that the participants took differed very much with regard to their direct living environment. Participants reported that taken pictures with the camera made them reflect on their everyday practices, their neighbourhood infrastructure and their mobility patterns in new ways:

So, usually you just follow your everyday routines, and you think that all is fine or not. But when I had this camera in my hand and then somehow I had to take pictures of places that are important

Figure 11: Picture by participant 11 featuring one of the tower blocks. In the front is a big road/tram line.

to me or where I am often, I saw them in a completely different way. I mean, I think it's nice to have a bus stop in front of the door, but then I realized that in a completely different way. That's why it was worth taking a picture of it.

Hence, taking pictures facilitated the individual perspective making of participants, mostly with respect to their immediate neighbourhoods as these were the most common motives. Participants took pictures of those places they felt comfortable, places they liked etc. The differences depicted in the maps again became obvious in this task and the most common motives were tower blocks and old farm houses.

The two participants who live in Neighbourhood A took pictures of their neighbourhood where the tower blocks are in the back and recreational spaces and trees were in the foreground, demonstrating the quality of life in this neighbourhood (e.g. Figures 12 and 13). Other participants portrayed the old farm houses and family homes that characterise their neighbourhood. If they took pictures of the tower blocks, they looked rather bleak. For example, Figure 11 features a tower block with a big road/tram line in the front of the picture, and hence producing a very different image of neighbourhood A than Figure 12 and 13 that forefront green areas and a beautiful sunset.

Figure 12: Picture by participant 9 featuring a lake, trees and green spaces in front of tower blocks.

Figure 13: Picture by participant 10 featuring great green spaces between tower blocks.

These different perspectives of participants were also present in the neighbourhood maps. The pictures helped participants to see unfamiliar areas with the eyes of a resident and discover beauty in places they had deemed ugly or unattractive before. It allowed them to take their respective perspectives and overcome some of their prejudices to some extent.

Another probe that asked participants to portray their district was one of the postcards. For the postcards, participants were asked to draw a doodle or imagine an emblem of their district. The idea behind this probe was to learn about what participants considered to be unique about their district, what is characteristic and what stands out. In addition, this postcard was meant to stimulate creativity. Some of the participants drew, others just noted down a few key words. There were a number of interesting co-occurrences in the emblem postcard. Participants 1, 3, 4 and 10 all included *tower blocks* (Hochhäuser) and timbered

(Fachwerk) or *thatched houses* (Reetdachhäuser) into their emblem. For participants 3 and 4 it was the last on a list of characteristics. For example, asked about elements of an emblem in his interview, participant 4 added reluctantly “and a tower block, that’s how it is”. Participant 10 who lives in the tower block neighbourhood did not seem to mind the tower blocks. In contrast to others, she drew a number of tower blocks and next to it people. In the interview she had also pointed out how strongly connected people are in her neighbourhood. In order to account for other parts of the district, participant 3 also suggested including terraced houses in which families live.

Four of the participants (2, 4, 6, 10) included trees (or one tree) in their emblem. For participant 2 this was a reference to “holz” (engl. wood) in the district’s name. Participant 4 recalled that “there used to be a forrest here”. Participant 3 listed “wheat fields” as a reference to the district’s agricultural past.

Below are two examples of the completed postcards featuring ideas for emblems.

Figure 14: Postcard by participant 10.

Figure 15: Postcard by participant 1.

This particular postcard turned out to help the group to develop a joint perspective on the district that comprises of the differences revealed by the map task. When interpreting these postcards the participants expressed a shared desire to improve the image of the district as a whole, which helped to bridge their differences and dismantle prejudices amongst the different neighbourhoods. Throughout the process of developing a digital district guide an important motivation for all participants was their concern to improve the image of the district as a whole. This common objective helped developing a joint perspective on the district that interestingly emphasizes its diversity as an advantage.

One reason why the postcards and the photographs were effective probes for making a joint perspective about the district was due to the ambiguity of their tasks: The motives of the pictures differed between the participants featuring people, architectures, infrastructures, vehicles, places, obstacles, home, public spaces, private gardens etc. and together formed an assemblage of things that mattered to the participants and allowed to be queried for different types of questions. In this respect, the photographs as well as the postcard served as a *repository* of different preferences, experiences and routines.

3.3 Envisioning the Future: From Individual Uncertainties to Joint Future Challenges

A second postcard asked participants to respond to the question: “What will [district 1] look like in the future?” The aim was for participants to imagine the future of their district and invoke associations about visions and ideas for a service. We also wanted to learn how people felt about the future of the district in positive or negative terms, what they perceived to be the main challenges and issues and how the district could be improved. The returned postcards were similar insofar as most of them revealed an uncertainty regarding the future development of the district. However, they differed with respect to what exactly was perceived as problematic.

One issue that came up quite often concerned the perceived increase of the share of people with migration background in the district, which caused a sense of insecurity among some of the participants. Participant 1 explained her postcard as follows:

Yeah, well, it [the district] certainly changes yes. [...] It’s, yes, I’ll say it very carefully, you start to think, what I have quite clearly is a feeling of insecurity. I have to say that. I don’t want to say that it’s the refugees, but everything that’s somehow related, right.

And participant 7 expressed his wishes regarding the future as follows:

The future, what does it look like? That we don't have enough places for all the children and for all the nursery children and if one day this would be guaranteed, that would be a nice thing. Because that is not the case at the moment. We lack so many kindergarten and nursery places and in schools, the teachers feel overburdened, because now more and more children are coming in, who have a special need for support. I can't even imagine we could do that. If we still get more refugees now, how will that work? How can that be possible? So that would be a future project for me, all the children have a place in school and a place in the kitesurfing school, which I would also like to see in the future.

Interestingly both, participant 1 and participant 7, live in the neighbourhood where fewest people with migrant background live. In contrast, participant 9 who lives in Neighbourhood A, the neighbourhood that has always been very mixed with regard to the cultural background of its inhabitants, expressed a much more optimistic view on this issue:

Well, I'm not afraid now that too many foreigners are coming in or refugees or anything like that, I'm too serene in this regard. We've already been through all this and it was really bad here and yet it was still alright.

As the quotes demonstrate: the fear of alienation through migration is strongest amongst those who are not used to live in multi-ethnic and multi-cultural neighbourhoods. Participant 9 however has a long-standing experience in living next to "foreign" people. The postcards here helped to share this experience and thereby facilitated perspective taking. Other uncertainties that came up through this postcard concerned the future of the retail industry and the increasing development of green and recreational space.

Hence, the postcard relating to future-making facilitated participants' joint perspective taking and making on how they envisioned the future of the district. During the workshop, a joint perspective formed that moved away from the perceived issues themselves to the responsibility of policy and administration to respond to these future challenges. As participant 3 stated: "The local administration or city or whoever is responsible for it, would have to make sure that this works out [...]". The taking of the respective individual perspectives allowed to make a joint perspective with respect to thinking about how to tackle challenges rather than being trapped in a diffuse fear. Figure 16 depicts some of the participants during the workshop while reading each others responses.

Figure 16: Participants discussing the postcards at a workshop.

In addition, participants reflected upon what they were missing in district 1 and many mentioned that it was young people. Some said that this was also reflected in the fact that there are only few places for going out (e. g. for a coffee in the afternoon or a drink in the evening). Some believed this was also an infrastructural problem (e. g. with respect to the tramline).

A further part of the conversation circled around charity work in the district and how this may support the development of the district. One idea was an app to support this, e. g. a platform for people that need help in their neighbourhood. Some participants reported on how they were already helping older neighbours with their weekly shopping. Another discussion was around the idea to build student houses and make the district more attractive for younger people and in this way "raise" people who are willing to take over charity work.

Hence, when displaying the postcards in our workshop they served again as a *repository* that allowed to be queried as various ideas, concepts, objects were collected and allowed for a creative process. It also served to envision an ideal future.

4 Conclusion

The probes (also through the interviews and the workshop) provided an opportunity to establish the older participants as experts of their life course and of experiencing the process of becoming older. They also allowed them to document and reflect on their everyday practices and practices related to ageing, technology use, and the appropriation of the district when becoming older. Probes sensitised participants about certain aspects of their everyday practices and were hence tremendously helpful in iden-

Table 1: Articulation of socio-spatial dimensions of probes.

Socio-spatial dimensions of social inclusion [25]	Participants' expertise & their tacit knowing of the district/their neighbourhood	Articulation in probes
sense of attachment and social connection	– <i>knowing a neighbourhood</i> – grounded in everyday experiences of growing older in the district	– Dependent on own socio-spatial networks as depicted in maps (participants became experts for their neighbourhoods)
sense of security and familiarity	– <i>knowing where to find relevant information and resources</i> – definition of what relevant information is	– Avoidance of places where a lot of young people “hang out” – Location of toilets, benches – Access to public transport (information)
sense of identity, linked to independence and autonomy	– <i>knowing where organisations and places are located</i> , which services are provided, and how to access them	– Nice places, defined by green areas – Places of historical importance

tifying needs and resources. For the researchers they allowed to develop a better and more profound understanding of these practices.

Probes also facilitate the individual and communal perspective making and perspective taking of participants. Above we have presented some of the probes that we used during our participatory design project and how we used them. In contrast to other accounts found in the literature, the interpretations of probes were not used as an inspiration to us as designers (probes as response), neither were they used as mere representations of the interpretations of the participants. Rather we argue that the probes facilitated a process of perspective making amongst the participants and perspective taking between participants and researchers. There was a transition in the ways in which probes were interpreted from what was important to individual participants to what may be interesting to others.

Table 1 summarises how probes facilitated the articulation of the different socio-spatial dimensions of social inclusion.

The first dimension of socio-spatial inclusion that Wiles et al. [25] list is *older adults' sense of attachment and social connection*. This includes participants' knowledge about their neighbourhood and is grounded in their everyday experience of growing older in the district. This dimension came to be expressed in participants' wish to include nice places and walks into the digital district guide rather than merely listing organisations (e. g. related to health services). As such, nice places are dependent on the circumstances, abilities and preferences of older adults. For example, the second dimension listed by Wiles et al. [25] relates to the *sense of security and familiarity*. Knowledge about those places was important in order to be able to plan a visit. One of the tasks of our participants was to define what information was relevant and important, and what kind of attributes were useful. This dimension came to be expressed through data on the location of toilets and

benches, but also through information about public transport (e. g. how to reach a place) or information relating to accessibility. The third dimension relates to a *sense of identity, linked to independence and autonomy*. Our participants expressed a need to know where organisations and places are located, which services they provide and how they can be accessed. For example, information about the accessibility of public buildings enables people with mobility impairments to better plan their trips and hence increases their independence and sense of autonomy. This dimension was expressed through detailed information about nice places (such as the descriptions).

Overall, the probes helped to make participants become aware and to articulate their tacit knowing. For example, certain beliefs and assumptions they had about particular places in the district and whether and why they liked to go there or not. Being open with each other and being able to take perspectives about some of the differences, helped identifying what and why nice places were an important feature of the district guide. Hence, probes may enable perspective making and perspective taking within design teams of users, developers, researchers and others. In this respect, perspective making relates to Gaver et al.'s [11] intention to elicit unexpected ideas beyond the needs and desires participants already understood. Understanding probes as boundary objects may provide a fruitful way of conceiving and developing probes in participatory design contexts as well as conceiving of new or alternative ways of embedding their interpretation and reflection throughout the whole process and not just for requirements elicitation.

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