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Situating Digital Interventions: Mixed Methods for HCI Research in the Home†

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One of the enduring problems of researching and designing digital technologies for the home is that both media technologies and uses tend to be dispersed spatially and temporally throughout the environment and routines of home. This raises a number of methodologically challenging issues: how digital media technologies are situated amongst other technologies; how materialities and textures shape the experience of home; the ways in which practices of media use are entangled with the other activities and practices that are part of the routines of home; and how digital media content and communications create part of a wider ecology of communication and interaction in home environments. In this article, we outline a methodological and practical response to these questions and describe its application through the development of tailored interdisciplinary research methods.

RESEARCH HIGHLIGHTS

- This paper describes research undertaken within an interdisciplinary energy project that is seeking to explore domestic energy consumption and everyday digital media use through the individual and combined lenses of engineering, design, social and computer sciences.
- The paper describes the interdisciplinary application of two methods that were enacted within participants' homes: the interactive floor plan method; and video ethnography tour and re-enactment methods.
- The benefits of embedding design research in this way are discussed in relation to studying the use of technology in the home and recent research trends in ubiquitous computing.

Keywords: user centered design; human computer interaction (HCI); ethnographic studies; contextual design; energy demand reduction

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1. INTRODUCTION: STUDYING TECHNOLOGY IN THE HOME

Designing technologies to be part of the fabric of home is a well-established aspiration within the ethnographically oriented human computer interaction (HCI) literature (e.g. Crabtree *et al.*, 2012; Taylor and Swan, 2005; Tolmie *et al.*, 2002). Research towards this goal is often directed towards understanding how technology use is implicated into the domestic routines and social organization of the home. As Dourish and Bell reflect in *Divining a Digital Future*, the home has been 'envisioned as territory ripe for computational colonization' for decades (2011, p. 161). Science and Technology literature charts initial domestic-technological design ideas as often centring on the development of computers or robots that were optimistically framed as 'labour-saving' companions for the 'modern housewife' (see also Cowan, 1983). With the rise of information and communication technologies, the domestic sphere was rediscovered as an—increasingly networked—site for leisure and entertainment and, not least since the conception of the home office, for areas of work that had previously been reserved for activities outside the home (Morley, 2010; Silverstone and Hirsch, 1992; Spigel,

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2010). Most recently, ubiquitous computing has begun to shift emphasis from the notion of a world with computers 'in it' towards one that is more generally 'computationally augmented' (Dourish and Bell, 2011, p. 163).

This notion of technological immersion is especially pertinent to the project of the 'Smart Home'. Previously the material of science-fiction, recent advances in sensor and networking technologies, along with the vision of an Internet of Things, have opened up real possibilities for implementing smart home technologies. At the same time, former proponents point out that the idea of the smart home has felt 'appealing and imminent' (Harper, 2011, p. 3) for a while and yet, years on from the initial moments of innovation that put it into grasp (cf. Harper, 2003), it is far from moving into the mainstream of housing development. In parts, this can be attributed to the fact that smart home design often started from scratch, with visions of new, large, modern buildings that would create a safer, healthier and more efficient environment for its new—and seemingly ahistorical—occupants. Indeed, utopian technological visions tend not to be realized (Dourish and Bell, 2011; Strengers, 2013). In reality, at least within the British context, we find ourselves living in existing housing stock in which 'new and old media [and technologies] coexist in symbiotic form', requiring us to 'better grasp the ways in which we live with them' (Morley, 2010, p. 8). Indeed, change and technological transformation arguably build on and interlace with existing social, cultural, material and technological legacies: 'At moments of technological transition', Spigel argues, 'people often search for ways to balance novelty with tradition. As with radio or television before it, today's new technologies are subject to patterns of cultural adaptation that aim towards conserving familiar lifestyles' (Spigel, 2010, p. 61).

Technologies can therefore be conceptualized as being 'made at home' as they are appropriated and made sense of as part of the existing social organization of home (Grinter *et al.*, 2009; Sacks, 1992). Even if not 'smart' in their most accomplished form, digital technologies are considered to be increasingly woven into the texture, rhythms and routines of domestic life, rendering the latter worthy of closer investigation in its own right (Pink and Leder Mackley, 2013). This reality requires a new and more detailed understanding of how everyday life in the home is lived and organized (Dourish and Bell, 2011; Taylor and Swan, 2005). However, despite considerable interest in the home as a site for HCI and Computer-Supported Cooperative Work (CSCW) research, there is still, some argue, a lack of clarity regarding how to study the home in order to direct and inform design activities (Randall *et al.*, 2007).

In this paper, we introduce sensory-ethnographic research methods—the home video tour and routine re-enactments—along with user-centred design research activities that seek to trace the complexities of everyday domestic life with a view towards understanding digital technologies today and identifying opportunities to shape their future. We do so in the context of an interdisciplinary research project that aims to generate digital solutions for energy demand reduction in UK domestic dwellings. Many studies within the domestic environment have utilized similar methods, however, few provide more than a few sentences or paragraphs regarding how they were practically employed. In the context of this special issue, we have therefore chosen to describe the practical application of our methods in some detail as well as describing the theoretical lens of sensory ethnography that has been employed to direct the practical application of these methods.

2. THE CONTEXT AND THE ISSUES

Our project is played out in the complex context of energy demand reduction research. In this field, there is substantial disagreement across disciplines and theoretical orientations as to where responsibility should be placed with regard to energy demand reduction—government, industry, householders or all of the above (e.g. Shove, 2010). There is also a related question of where and when it makes sense to involve occupants in energy-saving processes, what such an involvement might look like, and where (semi-)automated systems might be appropriate.

To approach these questions and debates, we argue that we need to take some steps back. The first step is to base the design of digital interventions in the home on a detailed understanding of how digital media technologies are *already* situated and experienced in the home. For instance, we need to know how they relate to other activities and practices—in more and less routinized ways—and how interaction happens between people and technologies within the wider ecology of home. A further step back involves an in-depth reflection on how we might research such questions in the intimate space of the home, where we are seeking to uncover precisely those mundane, 'unremarkable' (Crabtree *et al.*, 2012; Tolmie *et al.*, 2002) and routine aspects of life that people do not usually (need to) talk about. It means that we need to reflect on the methods we use, and on the status of the knowledge that is produced through them.

Within the context of this special issue, our contribution is primarily methodological rather than empirical. We present an integration of sensory-ethnographic methods (Pink, 2009) with user-centred design research that is chiefly concerned with the generation of more sustainable ways of living through the design of new products and services (Haines *et al.*, 2007; Tang and Bhamra, 2012; Wilson *et al.*, 2013). In doing so, we seek to go beyond a narrow definition of ethnographic insights as merely providing user requirements for technological solutions and, instead, discuss how we might develop ethnographic methods that actually open up the design space and provide new ways of imaging the relationship between people and technology (Anderson, 1994; Dourish, 2006; Dourish and Bell, 2011; Taylor, 2009).

We begin with a brief outline of our project before discussing specific sensory-ethnographic and qualitative design research

methods, as well as the theoretical intersections at which these have developed in the context of energy research in the home.

3. LEEDR: LOW EFFORT ENERGY DEMAND REDUCTION

LEEDR is a 4-year interdisciplinary research project that seeks to explore domestic energy consumption and everyday digital media use through the individual and combined lenses of engineering, design, social and computer sciences. The study is set against the backdrop of the Climate Change Act 2008, the UK government's commitment to achieving a net reduction of greenhouse gases within the UK—across business, transport and residential sectors—by 2050 to at least 80% of those recorded in 1990 (UK Parliament of the United Kingdom, 2008). Based on a detailed understanding of energy consumption in the home, LEEDR aims to conceptualize innovative and robust technological interventions that will help reduce energy demand, both now and in the future within this residential sector.

Twenty family households in the UK Midlands were recruited via a variety of local media, schools and community groups, and snowballing. While, for technical reasons, recruitment was restricted to homeowners only, householders vary in terms of education, income and environmental consciousness. Our sample includes different building and systems types, and family sizes range from single-parent households with two family members to three-generation households with seven occupants. With the arrival of new-borns and the temporary or longer-term departure of adult children, occupancy also changed in the course of the project.

The study's longitudinal approach, its attention to detail and the continued interdisciplinary dialogue have produced both challenges and opportunities. In general, they have led to an extensive and diverse set of qualitative and quantitative data. Householders signed up to have their energy consumption measured for a period of up to 3 years. Monitoring included gas and hot water use, as well as electricity consumption at meter, circuit and appliance level (e.g. ovens, washing machines, hair dryers and media sets). Individual sensors also recorded room temperatures, 'occupancy' or movement, and the opening and closing of doors and windows (for a discussion of technical details, see Cosar-Jorda *et al.*, 2013). In this article, we focus on the study's in-depth ethnographic encounters and qualitative research activities that were conducted by LEEDR's social science and design teams, specifically the home video tour, routine re-enactments and the interactive floor plan. These qualitative exercises were designed to understand families and family life in relation to the social and material environments that they were part of. They also positioned family members in a variety of different ways; some methods elicited more traditionally conversational data, which allowed participants to present themselves as certain kinds of individuals or family units, with specific (moral) values, interests, dynamics, hopes and aspirations. Others focused more on the experiential and embodied elements of domestic life, foregrounding some of the tacit and situated knowledges that are part of domestic routes and routines.

Along with the energy monitoring data, these methods provided us with multiple entry points into the home as a key site for consumption, but one in which energy use is a *by-product* of the activities that make up domestic life, rather than their main focus. Here, we specifically focus on the role of the media and other digital technologies in people's home. Our interest in media use relates partly to its role in domestic energy consumption, but primarily we are seeking to understand it as part of the organization of home and how it could be ultimately used to situate future design interventions within the social fabric of the home.

4. A FRAMEWORK FOR UNDERSTANDING 'MIXED' ETHNOGRAPHY AND DESIGN METHODS IN THE HOME

Within the research carried out between the design and social science teams of our project, we developed two methods which were played out in the homes of our participants: the interactive floor plan method; and video ethnography tour and re-enactment methods. Both methods involved the sharing of research events and/or materials, so that the ethnography and design teams felt familiar with the others' work and findings. In this project, mixing methods meant approaching the research question from different directions, which were complementary in terms of their findings. As the following subsections show, the design and ethnography methods approached the home first by slicing across (mapping routines and movements), and second by going through (video tours and re-enactments of routines and movements). This enabled us to gain the view 'from above' and the view 'from within'. Therefore, we could see through the messiness and ongoingness of the reality of everyday life as it is actually lived as if 'sliced through' in two different ways.

These two approaches also complemented each other in their emphasis on understanding the experiential and unspoken elements of everyday life in the home. Sensory ethnography places the sensory, experiential and affective elements of lived reality at the centre of research design, conduct, analysis and representation (Leder Mackley and Pink, 2013). Our ethnographic approach is based on Pink's previous research on the home and everyday life (Pink, 2004, 2009) and has, as part of LEEDR, developed to focus on domestic life through three related prisms: place/environment, movement/practice, and the senses/perception. Elsewhere, we have drawn parallels between design research as framed through the lens of sensory ethnography and what has been described as the 'third paradigm' of HCI (see Pink *et al.*, 2013); their interconnections increasingly informing our design research strand. The 'third paradigm' of HCI, as outlined by Harrison *et al.*, has developed around a 'phenomenological viewpoint, in which all action,

interaction and knowledge is seen as embodied in situated human actors' (2007, p. 7).

Ethnography is widely used within HCI field studies of the home dating back at least as far as the late 1990s (e.g. Mateas *et al.*, 1996; O'Brien and Rodden, 1997; O'Brien *et al.*, 1999). The majority of studies adopt an ethnomethodological approach (e.g. Crabtree and Rodden, 2004; Crabtree *et al.*, 2012; Grinter *et al.*, 2009) which seek to produce ethnographic accounts that reflect a 'concern for the ordinary, practical common sense reasoning procedures which make up people's understandings of social life, the resources they use to make sense of aspects of the social world' (Randall *et al.*, 2007, p. 110). Because ethnography exists within HCI primarily to inform design, the accounts reported tend to be shorter and more focused on technology or artefacts than accounts directed towards a sociological audience (Taylor, 2009). This has led to the value of ethnographic studies being misunderstood by some within the HCI community who view ethnography primarily as a tool for generating design requirements or implications for design. However, the true value of ethnography is how it works at an analytical level to reveal novel ways of seeing the setting under investigation thus providing a route to discover new spaces for design when there is no predefined problem to solve (Anderson, 1994; Dourish, 2006; Taylor, 2009).

Over 10 years ago, Bell *et al.* (2003) called for a broadening of ethnographic approaches to studying the home in order to take into account how technologies are 'embedded within an ecology that is rich in meaning and nuance' as well as implying that ethnomethodological approaches derived from study of the world of work were not adequate for this 'new design challenge'. We concur with Blomberg and Karasti (2013) that both critical interpretive as well as ethnomethodological studies are valid approaches to studying the home. By proposing, in this paper, a critical approach less well known to HCI we are not seeking to dismiss ethnomethodological studies but rather to expand the 'play of possibilities' (Anderson, 1994) by providing fresh analytical routes to sustainable HCI design.

All of our methods have the movement of people and things as central to understanding how everyday life is lived in the home. Drawing on theories from anthropology and geography (e.g. Ingold, 2007, 2008; Massey, 2005; Pink, 2012), we view people, objects, material and immaterial flows as coming together in different formations to 'make place'. By following these movements and studying in detail specific intersections and interrelations, we can gain a more detailed understanding of their meanings and complexities. Our approach also finds parallels in recent attempts by scholars to track the 'choreographies' (Pirhonen *et al.*, 2013) or 'rhythms' (Nansen *et al.*, 2009) of domestic life. Indeed this element of our ethnographic approach intersects with the design research approach, which has also sought to follow the routes and routines of participants as they move around their homes. Therefore, it is through the 'comings and goings' of people, objects, technologies and intangible elements such as sounds, smells, sunlight through the window and draughts (Pink and Leder Mackley, 2014), that home is ongoingly constituted and reconstituted as a lived place. Technologies and their affordances equally play a role in the making of home, and therefore both the content and presence of media likewise can be seen to be both *part of* and *constitutive of* the home.

Therefore, we think of the home as a dynamic environment where, as researchers, we need to equally dynamically follow the action that is happening in it, and therefore try to follow how participants move in their homes. Our methods were designed to do this in two ways: by actually moving around with people, and by asking people to track their movements for us. In moving through homes with participants (with video) and mapping their movements in the home with participants on paper (mapping exercise), we encounter the home as an environment in movement and as an experiential context. Video offers an ideal medium through which to investigate and record the environment, movement and actions that occur as part of this (Ylirisku and Buur, 2007). In contrast mapping the home offers us the opportunity to see the movement of everyday life as documented by participants. Taking this theoretical understanding of the home as a material, mediated and sensory entanglement of people, things, technologies and the flows that they afford, we now in the next sections present a practical account of our methods.

5. MAPPING HUMAN ACTIVITY: THE INTERACTIVE FLOOR PLAN

The interactive floor plan activity was a generative task (Sanders and Stappers, 2012) designed to explore how individual families made use of the physical space of their home and to provoke discussion of family routines and dynamics. It was part of an in-depth engagement with the families during a 'Getting to Know You' (GTKY) visit in the early stages of the project. The GTKY was centred around a take-away meal provided by the researchers and shared with the whole family, an approach first reported by Mateas *et al.* (1996). The need to establish rapport and trust with participants is particularly important in the domestic context (Dray and Mrazek, 1996), and the meal, attended by both social science and design researchers, was central to building a comfortable and relaxed relationship with each family prior to the more intimate video tours that would follow some days or weeks later. Over the meal a semi-structured conversation was initiated by the researchers to explore the family's history in the home, their hobbies and interests, general views on energy saving and other environmental issues, and what kinds of digital media they used within the home. After the meal, but whilst still at the table, the interactive floor plan task was introduced. The floor plan maps were produced individually for each house based on sketches made as part of an earlier survey of the home during which the feasibility of monitoring energy consumption had been established. Each member of the household was given a

Figure 1. An interactive floor plan exercise in progress. ©LEEDR, Loughborough University, 2011.

pack of colour-coded stickers and asked to plot on the floor plan their typical daily routines and movements through the house, for a winter weekday and weekend day (see Fig. 1). Stickers were numbered to demarcate individual movements and activities in relation to times of the day. The conversations throughout the meal and activity were voice-recorded and later transcribed. Floorplans have been utilized previously when studying technology in the home. For example, Chetty *et al.* (2010) as part of a home networking study asked participants to sketch a floorplan of their house showing where equipment was located and which devices 'hogged' bandwidth. Mateus *et al.*'s (1996) pioneering study of home technology utilized a feltboard and pieces representing rooms, people and artefacts to enable participants to lay out a floorplan of their house, which was then used as a visual and tactile prompt to facilitate recollection of routine activities. Our task, like that of Mateas *et al.*, was designed to prompt and situate recollection (Mitchell *et al.*, 2004) of the 'unremarkable' (Tolmie *et al.*, 2002) and this was facilitated by using the pre-prepared floorplans. As families did not need to create their own representations of the home, they were able to focus immediately on recollecting their routines and routine interactions.

The task was designed to allow participation from children of around 5 years and upwards. Younger children's movements were often more closely entwined with those of their parents, and so adults would jointly fill in the blanks on their children's behalf. The schematic representation of the family home aimed to facilitate recollection of daily routines; the act of 'sticking the stickers' invited conversation among family members and sometimes involved participants challenging each other as to the most 'truthful' representation of their 'average' day. As such, the approach was informed by the work of Stappers and Sanders (2004) that demonstrates how the doing of creative activities encourages participants to express previously tacit knowledge about what they do and why they do the things they do. Through the act of creating something, tangible participants are freed to reflect upon and relate past experiences. The activity thus prompted animated discussion amongst family members that, alongside the creation of the sticker trails, provided insight into the natural rhythm of the home.

More specifically, visualizing and commenting on routes and routines allowed us to situate people's activities with regard to the home as both a social and spatial-temporal environment. Often participants themselves commented on the fact that the visual representation of the home, i.e. the home as observed 'from above', illustrated specific centres of activity, that is, spaces that were more commonly frequented by participants at particular times of the day (cf. Crabtree and Rodden, 2004). Moreover, the task enabled the design team to identify what appeared to be 'peak times' in participants' narratives and sticker trails. The activity of getting up and ready for school or work, for instance, involved family members' negotiation of spaces, artefacts and technology during condensed periods of time. With regard to media uses, patterns emerged for afternoon and evening routines in terms of families coming together around the main television set—often at the same time as using mobile devices, such as iPads and mobile phones—or, sometimes depending on the age of the children, dispersing into different spaces of the home to engage with mobile devices and secondary television sets remotely.

In this sense, we gained an insight into some of the personal and social uses of domestic media technologies, with an emphasis on concrete, identifiable and conspicuous media engagements. While not to be considered as accurate reflections of specific days in participants' lives—after all, they were describing 'typical' everyday activities—the floor plan task nevertheless helped us to contextualize subsequent ethnographic insights (as well as wider energy monitoring data in relation to people's activities across the day). However, as we discovered during the ethnographic work, it only told part of the story of digital technologies in the home.

6. THE HOME VIDEO TOUR

The home video tour followed the GTKY, again taking place at the relatively early stages of our project. To explore the interrelations between people and their environments in more detail, we used the notion of the 'sensory home' (Pink, 2004) as a key methodological entry point. Rather than asking participants how they consume energy in the home, we invited them to

guide us through their home and tell us what they do, on an everyday basis, to make it 'feel right'. This might include the way they decorated, cleaned, aired or generally appropriated different areas of the home. Some tours were conducted in researcher pairs and, where time and space allowed, other family members joined in. However, for reasons of practicality, the tour often developed as a collaborative research encounter between one ethnographic researcher and one member of the family—usually, though not exclusively, one of the parents. This had the advantage of gaining a deeper insight into individuals' experiences of home, while also learning about values, morals and social relations, for instance when one person's management of the sensory environment clashed with that of another. To a degree, the tour can be considered as an interview in movement, with artefacts and spaces serving as prompts for the exploration of everyday activities. It is also, importantly, an embodied experience for both researchers and participants, for instance allowing participants to perform—on camera—how they might go about specific activities (Fig. 2). For the researcher, being part of the environment of home meant that they could pay particular attention to both the material and immaterial (or less visible) elements that make up home in the context of different families' lives (see Pink and Leder Mackley (2012) and Leder Mackley and Pink (2013) for a more detailed discussion of using and revisiting video). These might include sounds, smells or flows of air, which were either discussed on camera, to elicit additional participant reflection, or noted in subsequent field notes.

Tours of the home are a well-established feature of HCI research, either as a component of ethnographic studies (e.g. Crabtree *et al.*, 2012) or as part of other fieldwork approaches specifically developed for studying technology in the home such as the Technology Biography (e.g. Blythe *et al.*, 2002; Burrows *et al.*, 2011). The method is so commonplace that often very little detail of how the tour was designed or conducted is provided (e.g. Brush *et al.*, 2011; Chetty *et al.*, 2007; Crabtree *et al.*, 2012; Pierce *et al.*, 2010). Tours may be used to find out where the technology is situated within the home often as part of exploring how it is interwoven into the 'wider social organization of home' (Crabtree *et al.*, 2012). The focus of the video tours conducted within LEEDR were less directly orientated around technology and whilst still attentive to how the home is socially constructed and organized, were primarily orientated to exploring the sensory aspects of home.

As we have illustrated elsewhere, with regard to the role of media in domestic life, the theoretically informed video tour enabled us to be attentive to how media and other technologies were *part of the home* and used to create a sensory aesthetic of home, rather than being simply *in the home* (Pink and Leder Mackley, 2013). There was on the one hand, a clear material presence of media devices and accessories, with screens, cables, printers, games consoles and other gadgets constituting part of the visual landscape of home. Depending on their mobility, we could focus on how different devices—and, with them, media content—moved around with people, and how people moved around in the home between different devices and content. As we followed up each video tour with a debrief which, as part of our ethics procedure, ensured that participants were happy with our recordings, we moreover learned about moments of technological transition and re-situating that happened when new devices entered the home or old devices were passed from one sibling to the next.

Yet, media technologies and content were also entangled with other (im)material, affective and sensory elements of home, as part of the ecology of home (cf. Grinter *et al.*, 2009). For instance, soundscapes were created via radio, television, stereo systems and games consoles, that more and less demarcated personal and shared spaces, and were welcomed or challenged by family members as such. Radio and television were often habitually used as background 'noises' whilst participants went about other everyday activities, such as cooking or ironing. Alternatively, participants described how more conspicuous engagements with audio-visual media, as they had emerged from the floor plan activity, were bound up with other sensory experiences such as bathing before settling down in front of the television or creating a cosy viewing atmosphere through heating arrangements or the use of draught excluders and other props (see Pink *et al.*, 2013).

Likewise, in addition to media technologies' material presence—which mainly manifested itself visually but also through sound or heat—participants elaborated on their digital presence, indicating how immaterial flows were part of how the

Figure 2. Video tour screenshot and video ethnography in progress. ©LEEDR, Loughborough University, 2011.

home was constituted and experienced. This was illustrated by their knowledge of flows of Wi-Fi and 3G signals around the home, which impacted on how mobile devices were positioned and where and when they were used and/or charged. The positioning of devices was also, in parts, anchored along participants' regular routes through the home so that they could be accessed in between chores. Engaging with these contexts, we learned how much energy consumption can happen 'in anticipation of' needs or uses; connectivity and connectedness brought with them a notion of immediacy, of living in the moment, but they were also anticipated immediacies, that is, they could only be enabled through planning ahead.

As these examples demonstrate, the video tour provided experiential routes through which to imagine families' everyday lives by attending to the relationships between people, their sensory and technological environments, and the activities that were part and constitutive of these. It lent itself to a thematic investigation of patterns and discrepancies between individual households but also enabled us to trace individual concepts, such as the notions of flow and movement, in more detail across the sample. Likewise, as evident in the next section, more detailed ethnographic examples allowed us to gain a deeper understanding of specific contingencies and interrelations.

7. EMPLACED KNOWLEDGE: ROUTINE RE-ENACTMENTS

One of our key interests in both media and energy use focused on transition moments in the home, and how these both involved and were marked by technological and sensory shifts in how media and energy were used. As we have already pointed out above, uses of media are embedded in everyday activities and with uses of other things. Therefore, in order to research this we focused on four routine and mundane but also key transitional moments in everyday life: getting up in the morning, going out, arriving home, and going to bed at night. These had partly emerged as pivotal moments during families' floor plan activity. Yet, the extent to which they became meaningful as moments of transition only emerged during participants' routine re-enactments. The re-enactment methodology seeks to uncover those everyday mundane moments in everyday life that people never usually talk about, not because they are taboo or difficult topics, but simply because they do not have any need or reason to ever talk about them (cf. Tolmie *at al.*, 2002). The re-enactment method adopted within our research is somewhat similar to the 'artefact walkthrough' method introduced by Bayer and Holtzblatt (1997) as part of their Contextual Design methodology and subsequently used by others to uncover and understand habitual and tacit routines within the home, see for example the Smart Home oriented studies of Davidoff *et al.* (2006, 2010). However, again our approach is more holistic and focussed less directly on technology use and more on the experiential aspects of home.

We use re-enactment of routines to draw on the embodied memories that people have of everyday movements and actions that they 'do not really think about' yet perform nearly every day, if not in exactly the same way, in ways that change incrementally, and that likewise might not be noticed (see Pink and Leder Mackley, 2014). As such, asking people to actually walk and talk us through their routines, functioned to both magnify and slow down for closer inspection the elements that constituted 'going to bed' or 'getting ready' to leave home (Fig. 3). These would, for instance, include switching off lights and devices during the transition to night time—in parts, again, to achieve the right 'feel', for instance in relation to what was deemed safe to leave on at night (see Pink and Leder Mackley, 2013). At the same time, we learned that evening routines were also a time for appliances and devices to come or stay on, specifically with regard to washing machines, dishwashers and tumble driers, but also in terms of digital recorders, Wi-Fi routers and mobile phone chargers.

Indeed, we found that generally timers were an important part of everyday life and technology in the home. Timers for ovens, dishwashers, washing machines or tumblers were used to achieve a certain end result by, or during, a given time; the aim was for a device to switch *on* without actively switching it on. This was, for instance, employed by participants to make use of cheaper night time energy options but also figured in their considerations of when (the noise of) machines might interfere with other situated sensory aims. Using the timer on televisions and radios as part of a bedtime routine seemed different in that here the focus was on not having to actively turn *off* a device. Participants repeatedly showed us how they would set up their television, radio or stereo system to be able to drift off while it

Figure 3. Evening routine re-enactment. ©LEEDR, Loughborough University, 2011.

was on. In both cases, timers enabled things to happen in the background, as controlled ways of not having to control.

8. CONCLUSION: METHODS AND APPROACHES FOR RESEARCHING AND DESIGNING DOMESTIC TECHNOLOGIES

In this paper, we have presented a number of strategies for researching technology use in the home. The above examples demonstrate how our research process was in itself situated differently—spatially and temporarily—within the contexts of families' everyday domestic realities, depending on how we chose to map and trace participants' activities in the home. Importantly, our combination of methods allowed us to cross-check participants' accounts and explanations, fill in gaps and explore discrepancies. At the same time, we did not expect findings and 'trails' to overlap and match completely but to provide us with slices of everyday life as lived.

Despite our desire to experience the reality of domestic family life, all three methods were researcher led and can be viewed as disruptive interventions into the home and therefore disruptions to reality. Sensory ethnography acknowledges the situated role of the researcher in the home and production of the video is considered theoretically as a collaborative encounter between the researcher and participants (Pink and Leder Mackley, 2012). However, this does not necessary reflect how the participants feel about escorting researchers into the private spaces of their home or how honest they choose to be. For ethical and practical reasons (we wanted the families to stay engaged with the project for over 3 years), we designed our research approach to build trust and rapport with our participants. The sharing of a take away meal as part of the 'Getting to Know You' study was designed to provide a familiar social interaction for participants within the unfamiliar and perhaps threatening context of 'taking part in a study' (Portigal, 2013). The situating of initial project activities around the dining or kitchen table likewise represented an attempt to respect the privacy of the family by utilizing a 'public space' within the home that is naturally associated with welcoming guests (Kanstrup and Christiansen, 2006). The video tours took place on a day subsequent to this visit and, with the permission of participants, more private areas of the home were encountered. Although examples of researchers shadowing everyday routines from the beginning of the day onwards are reported in the HCI literature (e.g. Iacucci and Kuutti, 2002), the re-enactments took place at times of day convenient to the participants rather than first thing in the morning or last thing at night thus enabling participants to maintain control over their privacy. As a consequence, the researcher was less emplaced within the research setting than desired. Interestingly one of the key routes to understanding family life within the project lay outside of the staged field study encounters reported in this paper. The energy monitoring equipment was maintained by the engineering team and one researcher in particular regularly visited homes to change batteries and sensors. This researcher developed considerable knowledge of the families, their activities and routines and often reported on the arrival of new technology into the home and changes to work and domestic routines, knowledge acquired when scheduling visits and through informal social interaction. Whereas efforts were made to capture her knowledge in order to inform the social science research, future interdisciplinary projects could more fully utilize these necessary and routine maintenance encounters in order to embed research more fully in the home. The maintenance activities could, for example, be carried out by the ethnographer who will gain more insight into the social organization of the home as they become a more familiar visitor with regular permitted access to most rooms within the family home. The ethical issues that arise from intentionally observing the domestic environment when permission for entry is granted for another purpose of course need to be explicitly considered within the study design.

We have approached our ethnographic research through a set of theoretical commitments that had already been developed through extensive research into everyday life in the home. Our ethnography therefore did not simply uncover what people do in the home, but rather offered a framework for understanding both everyday practical activity in the home and the home as a sensory environment. Through their situated, embodied and performative nature, the research methods presented above have provided different entry points into the more and less routinized activities that make up domestic life, with a specific focus on what they reveal about the embodied relationships between people and technology in the home. Randall *et al.* (2007) in 'Fieldwork for Design' argue that theoretical choices within interdisciplinary work should be guided by what a particular theory illuminates and sensitizes. Our choice of a sensory ethnography approach is therefore informed by our desire to prioritize analytically consideration of the experiential and sensory aspects of home as we believe these provide opportunities to open up new spaces for design and encourage radical re-framing of the 'domestic energy problem'. This should not be interpreted as a call to negate other analytical routes into the home rather as an attempt to open further the 'play of possibilities' being considered within sustainable HCI.

The 'turn to the social' has since the late 1980s been evident in HCI studies of the home and is currently gaining considerable momentum within sustainable HCI (Disalvo *et al.*, 2010). From its early stages this field has been shaped by a recognition of the situatedness of human action (Suchman, 1987) and significant studies in recent years have sensitized researchers and designers to consider how future technologies might be integrated into existing everyday practices (e.g. Crabtree *et al.*, 2012; Grinter *et al.*, 2009; Tolmie *et al.*, 2002). As existing research has shown, everyday life in the home needs to be understood beyond the social and the psychological in order to account for the ways in which technology is experienced and 'made' as part of a material and sensory environment. Our particular approach has sought to situate everyday life in the home, within a wider ecology of

social, sensory and material relations and the methods presented provide a practical strategy for achieving this.

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