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The value of values: resourcing co-design of ubiquitous computing

John Halloran[1], Eva Hornecker[2], Mark Stringer[3],
Eric Harris[4], Geraldine Fitzpatrick[4]

1. Department of Computing and the Digital Environment,
Coventry University, Coventry
John.Halloran@coventry.ac.uk

2. Department of Computer and Information Science,
University of Strathclyde, Glasgow
Eva.hornecker@cis.strath.ac.uk

3. Agile Lab
www.agile-lab.co.uk
mark@agilelab.co.uk

4. Interact Lab,
Department of Informatics,
University of Sussex, Brighton
erich@sussex.ac.uk; geraldine@sussex.ac.uk

The importance of values in design work is gaining increasing attention. However, some of the work to date takes an approach which starts with generic values, or assumes values are constant. Through discussion of three accounts of value discovery and value evolution in projects focused on exploring novel uses of ubiquitous computing, we complement current thinking by arguing for the use of users' values as a resource in the co-design process. In particular, this paper shows how users' values: (a) are spontaneously expressed whether or not particular elicitation methods are used; (b) are not fixed, but can change dynamically during the co-design process in response to ideas, prototypes and demonstrators; (c) help mediate and shape the relationships of users to designers; (d) can support users' creative, functional and technical engagement in co-design – areas that can often prove difficult. Focusing on practical examples that demonstrate this approach, we conclude that values may act as a central resource for co-design in a larger variety of ways than has hitherto been recognised. t

Keywords: Values, co-design, ubiquitous computing, user-centred design.

1 Introduction

Values have become an important topic in design. Since values embody ideas and qualities that people find important and worth pursuing and attaining, it is now recognised that products that resonate with users' values will be more successful. (In the absence of a generally accepted alternative, the term 'users' will continue to be used.) Thus, 'value sensitive design' has been an expanding research program since the 1990s (Friedman, 2004), and 'values' is a keyword in Microsoft Research's report on the question of what Human-Computer Interaction will be like in the year 2020 (Harper *et al*, 2008). In designing technologies, it is more important then ever to identify and work with users' values.

There are many different approaches to this. Some focus on a general, pre-defined value selected by the designer, for example privacy or eco-friendliness. These can reflect the need to be aware of, and critical about, the values that products represent, and to remind designers of their ethical and social responsibilities (Friedman et al. 2002, Friedman, 2004; Ross *et al*,

2007). Others aim to elicit users' values in order to inform design, sometimes referring to pre-existing value taxonomies (Petersen et al. 2004, Voida and Mynatt 2005, Cockton 2006, 2008) or point out that it is important to discuss values with users in order to enable them to think about innovative solutions (Sanders 2005, Sleeswijk Visser et al. 2005, Sanders and Stappers 2008). However, there is still insufficient emphasis on how user values can drive the design process as it unfolds, and on what this may mean.

This paper reflects on three projects, all concerned with the problem of co-designing ubiquitous computing with users in areas that we term 'opportunity spaces' (Hornecker *et al*, 2006; Halloran *et al*, 2006a): spaces where there are many new options, but no pre-defined problem or product. This generated a number of challenges: to effectively engage users in ideation and design; to develop ideas for future ubiquitous computing applications in novel domains; and to negotiate stakeholder relationships. The projects aimed at diversity in terms of application fields and user groups in order to see what factors were generally applicable to working with users in such domains. The research team intentionally started from the assumption that technology designers do not necessarily know what might be the best potential uses of ubiquitous computing technology. To find out what ought to be designed and how, a bottom-up approach was chosen, based on engaging with real people's lives.

What we repeatedly saw across all three projects was the importance of values. As time went on and we moved between projects, this suggested an approach to using values as a resource for co-designing ubiquitous computing. Our observations, and their implications for working with users in a co-design process, differ from the literature in a number of ways.

First, as well as being pre-selected, values can emerge as part of the design process. As users worked around ideas, concepts, prototypes, and demonstrators, we found that there was no need to explicitly elicit values or to think about which might apply to them. This is because users express values whether or not one looks for them. From worries about depersonalization, through issues with responsibility, to the idea that technology has to be fun, we found that users frame technology - what it is for, what it does, how it should be designed and evaluated - in terms of spontaneously-expressed values. Listening to and acting on these serve important purposes in co-design.

Second, values are not always explicit, or general. In working with different groups of users, we came to understand that values can be specific and tied to the everyday practices of particular people. Values can also be implicit or latent, expressed only when users are challenged, for example by other users, or by developments in the design process. Such specific, emergent values can serve an important role in establishing detailed direction in co-design.

Third, the relationship of values to design is dynamic. Values are not only a resource to frame technological development; they are also caused by it. For this reason alone, values may well be a more crucial resource for design than has hitherto been recognised. When users see values represented in an evolving design – which may be their own, or those of other users - this can promote reflection on those values, leading to value development, and even change. This dynamic, reflective process can bootstrap difficult aspects of the co-design process. It supports users in producing creative ideas, as well as understanding and 'owning' the co-design process. Recognising and working with this means that values can act as an important practical resource for grounding co-design and informing it as the process unfolds.

Finally, values mediate co-design relationships, helping define roles, expectations and responsibilities. It is important to build relationships between ourselves and our co-design partners (users) which recognise that their relationship with design may be less informed, and more time-pressured, than ours (Hornecker *et al*, 2006; cf. Cederman-Hayson and Brereton, 2004; Brereton and Buur, 2008). Co-design relationships have to be built on mutual trust, which is fostered by awareness of, and respect for, each other's values. Designers also need to ensure that users' engagement in the co-design process delivers clear benefits to them (Brereton and Buur 2008).

This paper provides a detailed unpacking of these findings and spell out their implications. In particular, we show how we came to see values as a major driver for co-design, which can

resource and shape it; and we demonstrate how we adapted our approach and interacted with users in ways that depended on the values they were expressing.

2 Background

2.1 Ubiquitous computing and co-design

Ubiquitous computing moves 'beyond the desktop' (Weiser, 1991) in terms of composition, location and application. It offers novel multi-device arrangements including wireless infrastructures, embedded sensors, computing components, handheld devices, and location-sensitive information delivery, distributed, embedded in and integrated with the environment. This opens up new possibilities for activity and interaction that take computing beyond the world of work. In common with many other researchers (Truang *et al*, 2004; Gaver, in press; Buur and Brereton 2008; Ylirisku and Vaajakallio, 2007; Iacucci and Kuuti, 2002), we are interested in how to design ubiquitous computing to support and transform the everyday lives and activities of real people.

This approach generates a number of challenges. It means that working with users involves more than the evaluation and field trial of a designer-led project, and is not necessarily a component of a solution-based approach given a problem definition. Rather, it is itself a process of discovering what it is that could be designed in the first place. Thus, it is necessary to involve users in finding out what is meaningful and valuable for them, while being grounded in their lives. However, in attempting to design for the unmet needs, latent concerns, values and dreams of users (Sanders, 2005; Sleeswijk Visser *et al*, 2005), questions arise around what skills and roles are important, and how these should be distributed between the researchers and the users. Co-design with users presupposes, for example, the involvement of users as designers. This assumes that users have insights and expertise concerning what they do and what designs are appropriate. But there are known issues in working with users in this area: they may be less technically informed than the designers; have little experience of ubiquitous computing (Truang *et al*, 2004); and have limited time (Cederman-Haysom and Brereton, 2004). In addition, when working in opportunity spaces, there is no pressing need to motivate users' engagement. At the outset it is unclear what the result might be, and whether the effort will be worthwhile. There is a need for effective approaches to engaging users in ubiquitous computing co-design scenarios to help address these challenges and produce effective results.

2.2 Values in design

Technology design is increasingly concerned with the moral, personal, and social impacts of new products (Harper *et al*, 2008). This reflects historical attempts of design movements to propagate certain values and to achieve societal change (Ross *et al* 2007). Participatory Design, one flavour of co-design, was motivated by the democratic notion that a large part of the power to design workplaces and practices should be passed to users (Greenbaum and Kyng, 1991; Törpel, 2005). Thus, different research addresses the question of how to design technology that serves users' and societal needs. Much of this is now converging on values.

Some recent research has been concerned with revealing, exploring and critiquing the values technologies may embody. Reflective Design (Sengers *et al*, 2005; Gaver, in press) is motivated by the insight that commonly held social values may be unconsciously built into technologies, and then passed on to users. For example, engaging with a museum tour guide can convey a value – that the museum curators are the authority while the public are not. Once realised, this value can be questioned by users and new technologies built which, for example, allow users to contribute their own knowledge and responses to exhibits. Gaver (in press) argues for the design of objects without a clear purpose, which encourage 'an attitude of speculation', provoking users into exploring their own values. The Home Health

Horoscope, for example, generates horoscopes from sensor data collected in the house, leaving interpretation open to the inhabitants. Relatedly, Dunne (1999) and and Dunne and Raby (2001) use surprising, provocative or intriguing designs to encourage people to reconsider their relationship with technology, turning artefacts into a social commentary and critique that aims to stimulate debate (e.g. a chair that vibrates in the presence of electromagnetic fields, a GPS-enabled table that displays its known GPS coordinates or is 'lost', and a cushion that is supposed to shield users against 'electro-smog'). In a similar vein, IDEO designers developed provocative mock-ups of mobile phones, which modify their users' behaviour to make it less disruptive, e.g. requiring them to play the phone like a flute (aloud) to call a number, or giving them an electric shock when they shout (Economist 2003). This approach enables us to move beyond accepted images.

Friedman (2004; see also Friedman et al. 2002) has looked at how pre-established moral values such as user autonomy, human dignity and freedom from bias, can be reflected in design of technology. Value-sensitive design works with values uncovered by large-scale surveys, such as the need for privacy and transparency in the ability of computing to gather information covertly. This feeds into projects that, for example, focus on providing information about cookie behaviour in browsers. There is a clear implication: a specific value of importance to large numbers of users informs design from the outset. However there are less direct implications for co-design.

Ross *et al* (2007) investigate how to design for meaningful mediation, starting from the premise that devices change the way one experiences and is involved with the world. Being meaningfully engaged means being involved in activities considered valuable, such as sharing time and socialising with friends or family, whether this is an end in itself, or other activities are involved such as preparing dinner for people. In a series of design exercises Ross shows how the same functionality, based on different value systems (or ethics), can result in completely different product designs. For example, an 'intelligent lamp' can be designed to evoke feelings of belonging and being in control or of being helpful and serving others.

In her work on generative design, Sanders (2005; Sanders and Stappers, 2008; Sleeswijk Visser *et al*, 2005) has argued that the embedding of computing in leisure and domestic environments, and not just work, has brought it closer to people's values and concerns. Chief amongst these are the need for creativity and freedom from the consumerist values built into much of current technology. The generative design approach works with users to create technologies that are open to user adaptation and appropriation for their own creative purposes. Thus, a major issue in design is to reveal users' implicit values and to address these (Sleeswijk Visser *et al*, 2005). This approach, then, moves into uncovering values of specific user groups and working with users on concrete design projects, although it has a specific researcher agenda to move away from consumerist values. Unfortunately, only few publications by Sanders herself go beyond the general philosophy to describe the methodology in more detail. More recently, a range of case studies of generative design have been published by other authors who have adopted these methods (Sleeswijk Visser and Visser, 2005; Ylirisku and Vaajakallio, 2007; Ylirisku et al, 2007).

Other work links the identification of values to specific methods. Voida and Mynatt (2005) use Rokeach's taxonomy of values to start identifying what is important to users. Ross *et al* (2007) refer to a taxonomy from Schwartz (1992). Values include, for example, family security, independence, and responsibility. Users' values are elicited through 'value probes', based on Gaver's cultural probes. Haines *et al* (2007) elicit information about specific values ('things you value about your home'; 'things about your home that make you feel safe and secure') through a modified form of cultural probe – a 'mission pack' where the main resulting data is photographs. These can be analysed to identify which technologies are associated with what values, and in what ways. Petersen *et al* (2004) elicit basic assumptions, lived values and espoused values (desired, but not acted out) in household visits and use the identified value sets to generate design ideas, focusing on inconsistent value sets and value conflicts as potential areas of innovation. These authors point out that their research, in contrast to that above, is not about general moral values, but those of specific user

populations. Rather than driving design, they 'seed' it: thus values are seen as one resource amongst many in generating design concepts.

Cockton (2006) has argued that values are a key dimension in design, which 'unifies' it. He points out that value-centred design makes technology 'useworthy', that is, it can enhance adoption and uptake. The involvement of users in co-design also serves this latter purpose, so Cockton's approach suggests a good fit between values and co-design. However, the question of how values can be uncovered and decided upon in specific cases of design, including co-design, is left open.

Cockton's current work (cf, for example, Cockton 2008) focusses on 'worth' rather than 'values' (although the two seem closely related), and an important aspect of this approach is that if applied successfully to design, it could help ensure that technology has enduring worth beyond instances of interaction that can be evaluated as successful (cf. Harper *et al*. 2008). Cockton thus draws attention to worth as a way of evaluating technologies beyond, for example, usability testing. This is also a key aim of co-design: to create technology which is of lasting worth to its users, where there is ownership.

From this review it can be seen that values are an important aspect of current approaches to design. Values can be conceptualised in different ways. They can be conscious or unconscious, public or private. They can relate to the general population or to specific user groups, and hence have general or specific application. They can have different impacts on design, including providing inspiration, acting as fundamental aims, closely informing design, or to be considered for evaluation purposes. Yet in the literature review some common tendencies were identified. First, some approaches apply a set list of generic values, taxonomies or high-level goals. Second, many approaches assume that values are constant, providing a fixed frame or direction for design. In the approaches discussed, values tend towards being defined early in the process, rather than being reconsidered continuously in engagement with users. Third, only rarely is the relationship of values to the design process as it proceeds and unfolds discussed.

Our contribution in this paper is to complement these understandings and uses of values, by clarifying their role as a spontaneously emerging, dynamic resource for co-design when we take a bottom-up, data-driven approach with specific groups of users.

3 The projects

Domestic Technologies, SensorPlay, and Chawton House were three projects conducted by the Interact Lab at the University of Sussex with a shared motivation: to explore ways of co-designing ubiquitous computing technologies with specific groups of users. They were carried out as part of the British EPSRC Equator IRC in which, over 6 years, 7 British Universities were involved in designing and deploying novel Ubiquitous Computing technology in practical settings, focussing on unusual application areas (Crabtree *et al*, 2006; Gaver *et al*, 2007; Barkhuus *et al*, 2005; Rogers *et al*, 2005).

All three projects used a mix of ethnographically-oriented and experimental methods, including observation, interviews, co-design sessions, and explorations with prototypes. They varied in the specific techniques and methods used, and in their scope and duration. Some projects aimed at generating ideas for applications and application areas, others at developing and testing an actual system.

Domestic Technologies aimed to complement work in Smart Homes (Intille *et al*, 2005; Aldrich, 2003; Helal *et al*. 2005) by engaging with adult occupants of homes and their ordinary, everyday concerns before developing any technology, with an open brief and user-directed. *SensorPlay* took a different point of departure: it was technology-driven in the sense that we looked for novel ways of deploying a given technology in a particular user setting, here physical games and applications in the home for children, but was open in terms of the use made of this technology. *Chawton House* was a project where the curators of an English country estate and heritage site (famous for its association with Jane Austen) were interested

in new and innovative ways of offering tours and activities to their visitors, without a specific brief.

The first two projects focused on the early design phases of understanding the use context and engaging in ideation around potential types of applications. For Domestic Technologies, two iterations of user studies were conducted, investigating how technology is used in homes and the potential uses of sensor technology, identifying issues, themes and areas for applications. In SensorPlay, co-design sessions with children and teenagers were run alongside technology development, one informing the other. For Chawton House, a full iteration through a user-centred design process integrated with co-design was achieved culminating in a complete prototype which was tested in the field. This project started out from an application idea, but still had a lot of openness in terms of how this idea would be fleshed out and implemented, and how it would be appropriated by users.

While we worked with a specific suite of methods, our approach was designed to be sufficiently open to allow the co-design process to establish itself as a result of our interaction with users. This gave users freedom to contribute in ways that users chose. Across all three projects, we found, through observation and discussion, that users expressed values. Further, as we worked with users, we found that these values could - and should - be treated as an important, if not central resource in the co-design process.

Conducting three projects in parallel supported this insight, experiences from one project triggering reflection on similar issues in the others. That the projects were located at different stages of an overall design process led to different insights into the value 'theme'. While engaging in early ideation with users tended to highlight the local and contextual nature of values, longer-term collaboration with our co-design partners, together with deployment of prototypes, highlighted the dynamic nature of values and their role in sustaining a design relationship.

3.1 Domestic Technologies

The Domestic Technologies project (Fitzpatrick and Stringer, 2007; Stringer, Harris and Fitzpatrick, 2006) was dedicated to exploration of possible technology scenarios grounded in people's everyday lives. It investigated the role of existing technology in people's homes, and examined options for augmenting these everyday domestic environments beyond usual 'smart home' automation or monitoring scenarios (Intille *et al*, 2005).

Much ubiquitous computing research, including on smart homes, projects a certain picture of how we will live in the future, that focuses on efficiency, through automating functions and processes, instead of putting people in control and empowering them in the pursuit of their own goals and dreams (Gaver, in press; Rogers, 2006). However, these values are not necessarily shared by ordinary people. Going into people's houses, we found that they are interested in other values, including ecological and social concerns; renewable energy, such as wind and solar power; 'humane' pest control; and what images and impressions are conveyed to visitors. We saw that many of these values were 'aspirational': people wanted to have these values, to be seen to have them, and to be able to develop and 'live' them (see also Petersen *et al*, 2004). Technologies were less important than the values they embody, but at the same time technologies could help realize values. People wanted their homes to demonstrate their values, to portray their identity and to tell their story. Technology in the home needs to fit this picture in order for it to be appropriated.

This suggests a co-design approach where we look to identify values; see how these are currently being represented by technology; and then use this information to work on possible candidate applications that embody values.

3.1.1 Overview

The project was conducted in two series of sessions with inhabitants at their homes. The first set of sessions involved 10 local households. One or two adult family members, usually a

couple, gave us an in-home tour and were interviewed during this tour. They were asked to show us any technology in the house, used or unused, and to tell us how it came there, any criteria for purchases, how it is used, and any issues or problems around it. These visits took about 90 minutes and were video-captured for analysis.

The second series of domestic sessions took place about 2 months later. We used issues discovered across homes to seed a brainstorming and 3D-sketching session on potential applications that would employ sensors. Three households took part in this study.

3.1.2 First series of visits

In the first series of visits, we asked people to show us the technologies in their homes and to talk about it (Stringer, Harris and Fitzpatrick, 2006; Stringer and Fitzpatrick, 2007). We found an extensive array of technology. In many cases commonplace technologies including thermostats, burglar alarms and smoke detectors were not working properly and there were issues with how to set-up and control them. Similarly, many technologies that are regarded as unproblematic commodities by the research community, including ADSL broadband and wireless networking, rarely worked well and often took months to set up even at the most basic level, regardless of technical expertise of the owners.

Figure 1. Shelf full of unused electronic devices that are not thrown away but kept

In addition, homes were full of technologies and devices that were not used, either because owners had not managed to get them to work or found them to be useless, but could not justify throwing away. Technologies arrived in the home in a number of ways. Many were purchased and performance and technical features were only two of many reasons given for the purchase, including colour, design aesthetics and so on. More interesting was how much technology gets into homes as gifts and hand-me-downs, or is borrowed, inherited or taken home from the workplace after it has become obsolete there. Some objects are kept because of emotional attachments or a sense of duty, such as gifts by relatives, or souvenirs. These findings revealed that technology is related to the home in ways that are more piecemeal, ad-hoc and disorganised than is sometimes acknowledged and far removed from the 'Smart Homes' vision of streamlined technology efficiently and unobtrusively mediating domestic life for inhabitants.

An important finding was that issues with control and functionality were less important than might be expected. Rather than technologies *per se*, people wanted to tell us about their values and how they portrayed themselves. They wanted to tell us that they were the kind of couple that read a lot, did the crossword, or listened to Radio Four (English talk radio). Some wanted to tell us that they cared deeply about the environment and were intent on showing us their solar panels and compost heaps. Such objects were often simply there for what they represented about who they were: some objects, for example, documenting that a family cares about their carbon-footprint, and save water (even if the device does not work properly); or displaying a printout of the tides showing that "we are the kind of family that goes sailing – actually we don't". Homes and the identity of their inhabitants are interwoven.

There was surprisingly little dissatisfaction or problems with current solutions for information management, such as family calendars. Instead, participants mentioned other kinds of information that they would like, for example the amount of wind and sun reaching the roof (wondering whether solar panels should be bought), and the state of guttering which was difficult to access. They also valued information about the house that is not just functional, for example the coming and going of wild animals in the garden, the history of the house and the people living in it, and aerial photographs.

Thus technology in homes is about more than functionality, and people often care more about the values represented through the things in their home, rather than those things in themselves. This suggested three things: (1) the need for a 'realignment' of values. The values of automation and efficiency that we, as designers of ubiquitous computing, may bring to domestic environments, can be at odds with the values that the inhabitants of these environments have; (2) how to design technologies that represent those values; and (3) while a technology has to express values, its specific hardware and software implementation details are not necessarily determined by those values. Thus there is a challenge in how to derive requirements from values.

3.1.3 Second series of visits

The purpose of the second series of sessions was to see how the values discussed by our users, in combination with a demonstration of basic ubiquitous computing elements, could seed their imagination in inventing applications they might like to have. After discussing the themes uncovered in our first series of home visits, we carried out a number of activities to familiarise the participants with sensors. We focussed on a set of relatively commonplace sensors, including light, movement, touch, and humidity sensors, which are known from everyday contexts (fridge, burglar alarm, automatic light, speed camera). We attached a few example sensors to a laptop, so participants could see the sensor readings, and handed out pictures of the other sensors on paper cards, explaining what these detect and measure, asking participants to think about where these sensors might usually be used. Then we let them generate lists of things they like and do not like (objects or activities) in and around the house.

The main activity was then introduced as a brainstorming design task, telling participants, 'though we have the technology, we do not know what to do with it'. The instruction for the session was to pick something from the two lists of things liked or not liked, and to design a gadget that would 'make it better'. For these 3D sketches, participants were supplied with an assortment of craft materials (including play-dough, pipe cleaners, toothpicks, cardboard boxes, and paper). We asked them to place cards with depictions of sensors in their 'sketches' where the sensors would be. People used these cards very freely and sometimes invented ad-hoc sensors for what they wanted to detect, using abstract and/or common-sense language to describe their behaviour. Finally, participants were asked to show us where it would be placed, walking us to the location in the home to explain how it would work and be used, in form of 'show and tell'.

Figure 2. Showing sensors with laptop and cards, and designing in different homes

Figure 3. Show and tell. Left: the infrared device to record movement of mice would be sited in a corner of the ceiling. Centre: The spider trap. Right: the internet control device next to Celia's 'control chair'

Results of the domestic design sessions were based on specific needs, interests, problems in the house, or relations in the family, reflecting the local and situated nature of the design sessions. Rather than concrete solutions that could be developed as a product, they highlight values that can be implemented in various ways. The sensor technologies we worked with were treated as devices allowing broad types of functionality, which implicitly support values in ways that were not completely specified by the designs, and talked about primarily in terms of their function (cf. Truang *et al*, 2004).

For example Larry (all names have been anonymised) used the exercise to point out to his wife his wish for a wine-cellar, creating an outdoor wine cabinet with temperature and humidity sensors. This implicitly conveys being a serious wine-lover, and this self-image drives a design concept where sensors are only a small part of the picture. Jason created a system for his green house to water and control temperature by opening windows, and switching lights on.

Gina wanted an infrared sensor device in one of the kitchen ceiling corners which, each morning, would allow her to "play back a film and see where the mice come in", enabling her to put the trap in the right place. Suzie, in another household, designed a spider trap, notable in that it merely catches spiders which "scurry across the hall" without killing them. This reflects a desire for humane pest control while acknowledging the ecological value of spiders. These examples both revealed the relevance of pest control, and the potential utility of ubiquitous computing in this regard, but also point to the values expressed with the wish of doing this in a kind, humane, and ecologically sustainable way.

Controlling pests was only one instance of the more general value of 'being in control'. This, however, has considerable complexity with issues around gender differences, security, surveillance and so on, which show that the relationship of control to domestic environments is complex and nuanced.

One issue was who controls, how. In Clare's house, it was well accepted that she was the 'controller'. She had her special 'control room' chair positioned in such a way as to allow her to observe everything going on in the living room while reading or knitting. This was also where she wanted her device to be. In contrast, where there was more than one person with a stake in control, there could be tensions. One of the men designed a remote control to switch off devices in the house when leaving it. His wife commented, "He wants to control the house, just like everything else in his life, from a remote". This suggests that values thought of as applying equally in domestic environments - the desirability of control, for example - can apply to different people in different ways, and this can be a source of conflict.

Figure 4. Three designs. Left: Clare's wireless internet control and 'spying' device. Centre: Jason's green house. Right: Suzie shows us how a spider would trigger a motion sensor when entering the spider trap

Control values also played out in other interesting ways for Clare. She and her husband had finally succeeded in getting their wireless networking to work after several failed attempts, and had decided not to worry about securing it. We fed back to them the risks around people using their WiFi and briefly talked about security and this might have triggered Clare's design of a gadget to control the computing in their home. This featured several pipe cleaners stuck into a piece of play-dough. Clare told us, "Each of these [points at pipe cleaners] is gonna be one of my points of contacts. […] When I want the internet to work I twist this one [pinches one], when I want my computer to work [pinches another] and when I want to spy on my next doors neighbour's I twist this one."

Above we saw a conflict in values around control between genders; here, a design is used to ironically comment, and bring to light, a different kind of conflict - that of being unable to get a technology to work to represent the value required: privacy. In addition, without changing her tone of voice, Clare addresses both the values of privacy and curiosity at the same time, implying an interest in spying on neighbours. Having talked about the difficulty of securing one's network, she might have been thinking in terms of 'tit for tat' (if others can spy on me then I want to be able to spy on them), addressing values like fairness and equality. This example shows that there can be ambiguity and conflict in the values expressed by users. These constitute areas of instability and potential change, pointing to areas for innovation that might resolve or realign value conflicts (cf. Petersen *et al*, 2004).

3.1.4 Discussion

Our findings show that values can play an important role as resources in co-design. They are spontaneously expressed through what people care to tell us about, and the ideas they come up with, without being labelled explicitly as 'values'. They diverge from the values often assumed to hold for design of domestic environments, pointing to a different set of application areas. These sessions revealed values participants found important and cared about, which emerged through discussions of technology but are larger than particular designs. Focussing the design effort around particular technologies can lead to early concepts but also reveal conflicts.

The Domestic Technologies project led us to realize that the relationship between values and design in the space of domestic technologies is complex. In particular, the research suggests the need for a realignment of values between designers and users; as we have seen, users' values are local and situated (cf. Petersen *et al*, 2004), and even where they cross over with assumed values of designers - for example, control - they do so in complex and unpredictable ways. Thus, as designers, we may need to take more notice of such values. At the same time, while values can drive a design process, they underdetermine designs. The challenge is how to focus a design around values. We partially addressed this issue in the second set of visits, which demonstrates how design was framed in terms of values, but a longer process is required for further focussing. A key finding of the Domestic Technologies project was that values seem to be prior to, and broader than, design concepts. For example,

using light sensors to measure sunlight exploits their technical capability, but the design is not primarily driven by a technological consideration. Rather, it is driven by an ecological value. To extend this example, as a next step in a longer design process, researchers could present participants with different technological scenarios that embody one value in different ways, asking them to choose an avenue to pursue. Alternatively, such scenarios could be developed by the participants themselves, using, for example, generative design methods (Sanders and Stappers, 2008; Ylirisku, Yaajakallio, and Buur, 2007). These ideas were explored further in the Chawton House Project.

The Domestic Technologies project revealed the importance of values as a resource for co-design. In particular it showed how values can be expressed and acted on in design without there needing to be commitment to given technologies. Using values to frame a design process is consistent with the aim of co-design to produce technologies that are suited to user needs when there is no 'solution' to be addressed, but rather an open space of possibilities.

3.2 SensorPlay

The SensorPlay project consisted of a series of user-centred design sessions with children to explore near-future applications of sensor-based technologies. The project focussed on the methodological challenge of how to engage children in such design sessions where there is a relatively open opportunity space provided by a specific set of technology components and infrastructures that are novel to children, yet also constrain design possibilities. A number of design sessions with children of different age groups were carried out, each session taking about 1.5 to 2 hours. In all the sessions, we introduced the children to a technology, and then let them engage in imagining and sketching ideas for applications.

An issue on this project was how to structure sessions so as to support different groups of children in understanding the potential of the technology and developing creative ideas that make use of sensors. Thus, there were differences between sessions, including how we introduced sensors, which activities were carried out, and how the ideation phase was organized (Stringer *et al*, 2006).

Analysing the outcomes of this ideation process, we found that these do not just present application ideas, but more importantly, often express the children's concerns and values. Thus, a main output of this project was our realization of the importance of values as a starting point in design not just for adults, but also with children. This is an important issue to address, as it would indicate that despite differences in working with adults and children that are well-known (Druin, 2002), values can be equally important.

3.2.1 The project procedure and findings

SensorPlay took a different approach to the Domestic Technologies study but also presented applications including sensors. We ran four studies, involving a total of six design sessions. Details appear as Table 1:

Study	**Session**	**Participants**
Interactive Skipping 1	1	4 girls, aged 7-8 years
	2	3 boys, aged 7-8 years
Interactive Skipping 2	3	3 girls, aged 13-14 years
	4	4 boys, aged 13-14 years
Technology Ideation	5	4 boys, aged 13-14 years
Technology Invention	6	3 boys and 1 girl, aged 11-12 years

Table 1. SensorPlay Studies

We started Sessions 1 and 2 by presenting a 'mixed up monster' application, which used a force sensor, a web camera, an RFID reader, and accompanying tags (Stringer, Harris and Fitzpatrick, 2006). We were interested in whether a working application would support the children in understanding sensors, and coming up with creative ideas for new applications. In contrast, on the Domestic Technologies project, we introduced isolated components, demonstrating a more defined and limited technical possibility.

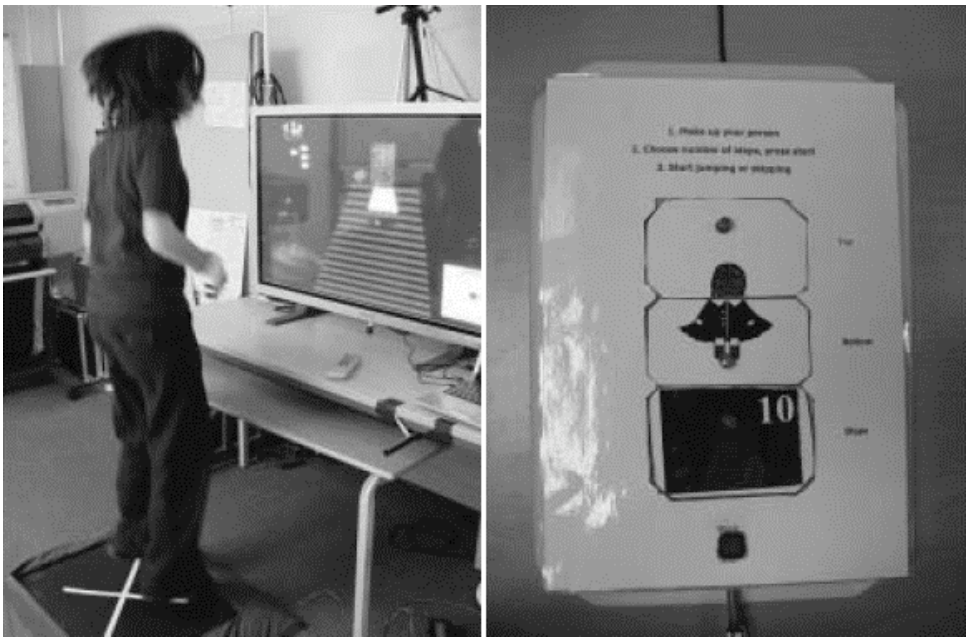

Figure 5. The skipping mixed up monster application. Left: skipping on platform. Right: assembling a monster from tangible tokens with attached RFID tags

The application involved children jumping, or 'skipping', on a platform to make a cartoon character climb stairs projected on a screen. First, the child configured a 'mixed-up' cartoon monster by choosing body components from tangible tokens with embedded RFID tags. The different body parts influenced speed, force and the number of skips/jumps required. The game was finished when the on-screen character reached the top step, at which point a photo of the child's face was superimposed on the mixed up body.

One aim of this study was to investigate how children's understanding of the game might inform design activities which would make use of the different technologies used to create it. Children explored the game one-by-one, and we asked each child to explain to the next how the game worked, in order to find out what they had understood. For all the 7-8 year-olds, there was no comment on the technology, only on what needed to be done: that the pad needed to be jumped on in order to reach the top of the stairs. Following their experience with the game, the children sketched and drew pictures of how they would change it. This resulted in ideas which emulated the game. For example, the second image from the left in Figure 6 shows, instead of a mixed up monster, a mixed up insect; and the stairs are replaced with a 'bouncy grass' hillock. Another idea, similarly, replaced the monster with an animal and the stairs with a tree.

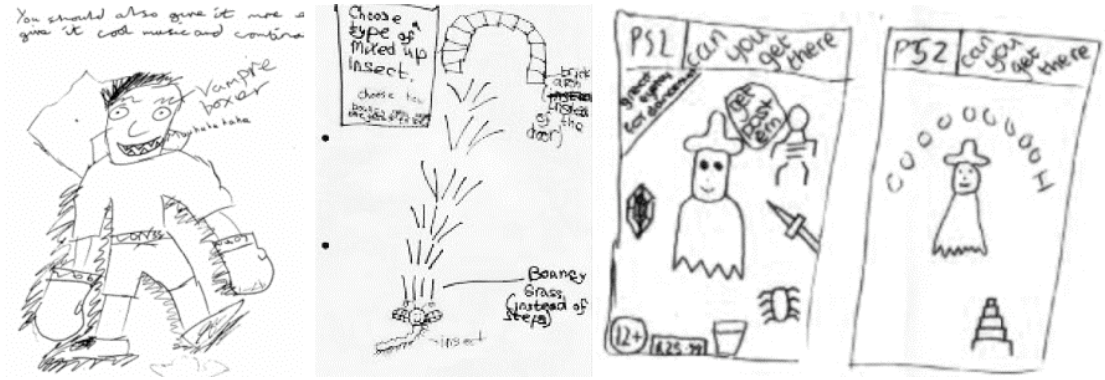

Figure 6: Children's designs from the Interactive Skipping studies. Far left: a vampire boxer (Study 2). Centre left: a mixed up insect that bounces on grass (Study 1). Centre and far right: a ghost that is attacked with swords (Study 2)

The second study, Interactive Skipping 2, featured older children, aged 13-14. The two sessions (3 and 4) resembled those with the younger children (1 and 2) in terms of what we asked the children to do. Again, the children's explanations to each other of how the game worked showed did not reflect understanding of the technologies involved. However, this age group differed from the younger group in that the children produced ideas that tended to resemble video games they knew. Girls changed the monster characters to animals and the environment to flowers, while boys added knives, bombs and axes. A recurring theme was that games should be of proprietary styles and types, reflecting gender conventions, game genres (fantasy, war) and resembling, for example, PS2 (see the image to the right of Figure 6), Xbox or EyeToy games, all of which were explicitly mentioned by the participants. This suggests both that children of this age favour familiarity as a value, and that technologies can embody values in ways that are hard to deny or to think past. Children also want to be 'cool' in front of their peers; they need to show they are into the 'right stuff'. This reflects our finding from the Domestic Technologies project, that people wish, through technology, to present a certain picture of who they are. The output of these sessions rather than being requirements for new applications, was an elicitation of such values.

The two Interactive Skipping studies resulted in two insights. First, it appears that values relating to gender and game styles have not emerged when children are 7-8, but are more marked in early teenagers. Second, we saw that our presentation of the technology was implicated in the kinds of values that were expressed. By evoking the notion of a video game with the application of the 'mixed up monster' game, we unwittingly channelled ideation towards previous experiences and values connected to video games. This has implications for how we as designers engage users if we want to move beyond the evocation of values built into existing commercial products. However, to do this does not necessarily require interventions or provocations *a la* Sengers or Gaver (Gaver, in press; Sengers *et al*. 2005). Other kinds of engagement may achieve this by avoiding over-determination of what a technology can do, which can happen when we present it integrated into applications. Thus, we wanted to explore whether a different session structure would elicit other ideas and values.

In the third study (session 5), boys aged 13-14 first collectively discussed sensor technologies and their application. We seeded this with three examples: a temperature sensor used in a thermostat, an infra-red sensor in a burglar alarm and a speed-triggered digital camera for vehicle speed traps. The teenagers were then shown four different sensors connected to a computer. We asked them to create a list of tasks they disliked doing about the house. This was to direct their imagination away from the gaming applications that had dominated the Interactive Skipping studies, toward their living situation. We provided them with a board-game-like plan of a typical bungalow home and asked them to think of possible sensor based applications and draw them on the board. This procedure was slightly varied in the fourth study (session 6), which featured a mixed-gender group. We asked the children to

think of some 'fantastic technology of the future'. This resulted in ideas involving robots and automation.

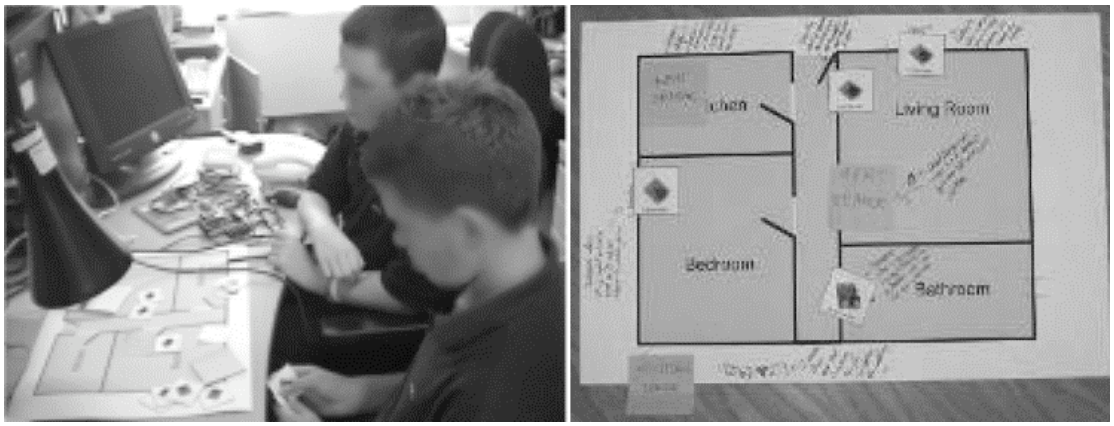

Figure 7. Children's sketches of sensor applications for the home

The third and fourth studies, then, introduced the children to components rather than applications. The ideas generated highlight themes or values children find important or perceive a lack of, such as safety, security, privacy, not getting into trouble, personal hygiene and personal assistance. A number of applications concerned safety or security, for example a force sensor on the window to alert people if the window is left open. Another common theme concerned personal assistance and avoiding getting into trouble, for example when the child was asked to take the washing in if it rained. A moisture sensor placed outside would sense rain so that you can then bring in the washing from the washing line. In a similar vein, technology was envisioned to help children make beds, detecting when it is vacated, or automatically clean up. Another recurrent theme was privacy, with applications that, for example, alert you when somebody is in the bathroom so you do not disturb them or an 'accelerometer' close to the bathroom door to alert you when somebody might come in while you are inside.

3.2.2 Discussion

In our first SensorPlay study, with young children, we could not identify a clear influence of values. However, the design work produced by the 13-14 year-old children who participated in our second study, shows that values that drive technological conceptions can be strongly influenced by conceptions of gender and by commercial products. In particular, children value games which resemble those that appear on proprietary platforms such as PS2, and which feature the kinds of content found there. From related research in involving children in co-design of play-oriented systems, we know that more implicit and longer-term approaches using a variety of creativity techniques can be helpful in eliciting more personal ideas from children (Druin, 1999, 2002; Jones *et al*. 2003; Roussou *et al*. 2007). To move from familiarity influencing design ideas to more genuine and personal themes not only involves a longer co-design process, and the building of trust, but also avoiding overdefining what can be done with a technology when introducing it and discussing it with children. The simplification of the third and fourth studies led to a different, more personally motivated set of ideas.

The significance of our research here lies not so much in the specific applications children envisioned, but in discovering the values they felt could be supported. These included privacy, self-representation, security, and avoiding getting into trouble. We found (as with the Domestic Technologies project) that these were expressed in unanticipated ways. For example, the prevailing assumption in ubiquitous computing is that privacy is about keeping what goes on inside a house unknown to those outside it. But for our participants, privacy

within the house was equally important. There are conflicts between parents and children on privacy, and ubiquitous computing can offer support for parenting through, for example, tracking and CCTV (cf. Harper *et al*, 2008). But these values are not necessarily those of children. Seeing values implemented in concrete designs and product sketches makes such conflicts explicit, where an abstract discussion and prioritizing of values might (falsely) indicate agreement. Eliciting values through creative generative activity might therefore have a clear methodological advantage in highlighting which values mean what to whom, in a given context.

The ideas generated by the older children on the SensorPlay project were driven by their concerns and values, expressed in their design work, just as with our adult participants on the Domestic Technologies project. In addition, this study demonstrated that revealing values and working with them involves finding a balance between possibly overdefining the space of possibilities by demonstrating applications, and leaving this space more open with components. For both adults and older children it appears that the latter is a fruitful way to begin a co-design process founded in values. Creativity methods, such as making lists of liked and disliked activities, can help avoid lack of direction that might arise from this openness, by providing a starting point from which to generate ideas, and to enable participants to focus on their everyday experience.

3.3 Chawton House

The Domestic Technologies and SensorPlay projects revealed a number of issues concerning the relationship of values to co-design. People spontaneously express values when they are talking about or considering technologies. Many different designs can represent a value, which means there is work to be done to successfully translate values into technologies that represent them. There can be conflict in the expression of values, revealing different people's attitudes to the same technology. Lastly, values are evoked by technologies, but if we are looking for people's 'real' values, we may need to avoid over-demonstrating technological applications, which can result in users' producing variations on the demonstration.

The Domestic Technologies and SensorPlay project, however, explore only the early stages of co-design. The third project we discuss, Chawton House, was more extensive. This project featured a full iteration through a co-design process resulting in a complete prototype and an evaluation with users. It shows that values are a crucial resource for the effective integration of users into a co-design process, which leads to their being better able to understand and engage with technical and functional issues, as well as, crucially, their buy-in. Here, we unpack the process, discussing how values emerged, evolved and changed; the interaction between values and technology development; and how values acted as a resource for co-design.

Chawton House is a sixteenth-century English country estate consisting of a large house and extensive gardens. Due to its association with the English writer Jane Austen, it houses a library of early English women's writing, which can be used by scholars on an appointments basis. However, since its restoration in the 90s, Chawton House has also attracted tourist groups, which are accepted in on appointment basis. While showing the estate to literature, garden, or architecture afficionados was not an original goal, it has become a welcome source of additional income. However, giving tours is not an official part of any person's job, creating an issue in terms of workload. Early on in negotiating our collaboration with Chawton House, the curators were concerned not to 'turn it into a Jane Austen theme park', and explained that accuracy of historic information provided to visitors was important. Thus, the aim of the project was to design a technical solution that would reduce the need for personally-hosted tours, but still would provide accurate information. Apart from these two constraints, the brief was open. The technologies that we were looking to employ included portable devices (PDAs) with a location-sensing infrastructure provided by GPS augmented by pingers (RF beacons).

We engaged in a co-design process with Chawton House over a period of six months. The main stakeholders were a group of three curators with diverse professional backgrounds (the director, the librarian, and the estate manager). We also worked with teachers from a local school, who wanted to explore the use of technology for fieldtrips – this being one option for potential visitor experiences.

We engaged with curators, as well as teachers, in a number of workshops to develop concepts and content for visitor experiences and discuss potential uses (for details see Halloran *et al*, 2006a; Hornecker *et al*, 2006). In July 2005 a demonstrator experience took place: a fieldtrip for schoolchildren designed by the teachers (Halloran *et al*, 2006b). Subsequent workshops with curators and teachers led to the development of a mobile authoring tool for visitor experiences, that allows end-user authoring of content and site trip experiences (Weal *et al*, 2006). This culminated in a second fieldtrip being run the following year using new content created by teachers with the authoring tool (Hooper, Fitzpatrick and Weal, 2008).

3.3.1 Overview

We carried out a number of activities with stakeholders, in particular a series of workshops with the curators of Chawton House, and with teachers from the school. In addition we observed tours given to visitor groups, and held informal interviews with other members of staff. The workshops with curators consisted of a wide range of activities, including working with maps, walking around the grounds, video presentations, discussions and interviews, demonstrations of system prototypes, and brainstorming and design of content and experiences. In-situ methods (cf. Ylirisku and Vaajakallio, 2007; Jacucci and Kuutti, 2002), such as walking the grounds with a curator who gave a tour to us, or walking around the house while playing audio files at appropriate places to emulate visitor's interaction with the new system, had an important role in enabling us to understand the curator's practice, and for curators to imagine how the new technology would work and what visitor experiences it might engender (see Halloran *et al*, 2006a). Later sessions focused on the authoring device.

Workshops with teachers used a similar set of methods, also including discussions of their aims for fieldtrips, and how they design and run them. Teachers decided to use the history and beautiful environment of the grounds to inspire children's writing, and support literacy education. Over a series of four workshops they developed a structure for the fieldtrip, and designed activities for the children. The final stage of detailed design took place in the gardens of Chawton House.

During the fieldtrip, children were prompted to interact with their environment to gather data, ideas and inspiration for a story based in the setting. Each pair of children shared a portable device with location sensing and the ability to record audio and text while they explored the grounds, free to go where they wished. At specific locations, content was activated. The device introduced the children to the location with audio clips. It then displayed a series of prompts designed to inspire children's imagination. For example, after listening to an audio clip about a part of the gardens named the 'The Wilderness', they were asked to explain the reason for this name. At other points in their exploration, the system invited them to find a particular spot and describe it; or to role-play and record an improvised dialogue between historical characters that lived in the house. Content was timed so as to allow children to follow their own impulses, and sequenced so that audio clips provided inspirational information for subsequent activities. Later, each pair went to two locations to develop their stories, thinking about character, setting and plot. Further details can be found in Halloran *et al* (2006b).

3.3.2 Co-design activities, technologies and values

The Chawton House project hinged on designing new visitor experiences with no explicit brief. Initially, we assumed that we needed to provide our co-design partners (curators,

teachers) with some technical and functional insight into what could be built. In our early workshops, we aimed both to gain insight into current practice, and to encourage users to come up with ideas integrating that practice with the devices and functions we had chosen. These included PDAs, locationing, and context-dependent information delivery.

Our first workshop looked at how curators currently provide visitor tours, and their thoughts about options for enhancing such tours. Our ethnographically-informed approach was intended to provide a way into the co-design process, and to become informed about our users' practice. We realized that, at this stage, participants did not contribute a great deal to technical and functional discussion. Rather, they expressed values. As with the Domestic Technologies and SensorPlay projects, these emerged spontaneously, without our deliberately eliciting them. These values were sometimes inconsistent. Curators expressed their excitement about new technology, and their hope that it would remove the need for a human guide; but the same time, it was stated that tours *should* be done by people "*to give that life and feeling*" that enthuses visitors. Thus, there was a basic conflict: technology versus human expertise and the 'human touch'. This conflict was key to the entire project.

In our second workshop with curators, we asked them to give us tours of the estate (which we recorded) to experience their existing practice first-hand. What was striking was that they all followed exactly the same route, and said similar things. There was a belief that certain items of information were important to cover, as well as a set route, and these notions were defended when questioned. However, one thing a context-aware system enables is liberty from a set route; it can deliver content related to the context (including location, visitor preferences, and previously experienced contents). One of our research-led aims for the system was to allow visitors to explore the grounds on their own, possibly choosing an individual path. However, curators initially expressed a commitment to fixed routes and a belief that their value lies in getting the right information across and ensuring that visitors do not 'miss' the interesting aspects. They found it difficult to envision such new practices, which would change their relations with visitors and with content, reducing the degree of control they could exert over the visitor experience.

Figure 8. Designing visitor experiences. Left: Curators looking at cards showing themes for a tour of the estate. Centre: Discussions around a map. Right: Detailed design of the fieldtrip in the gardens

Figure 9. In-situ methods. Left: Curator giving us a tour of the estate. Centre: Walking round the house playing recorded audio clips from a laptop. Right: Curator experiencing the prompts that children will encounter

In the third workshop, we wanted to demonstrate this possibility to curators. Using technology as an intervention and springboard (cf. Sengers *et al*, 2005; Dunne and Raby, 2001; Buur and Binder, 2004) can interrupt habitual thought, encourage reflection, and thereby result in re-evaluation of values. Free exploration of the grounds was one of our values, but it needed to be tested against what the curators valued. In the second workshop, we had made audio recordings of the tours the three curators gave us. We came to this third workshop having organised these into short audio clips relating to different places and objects. With the curators, we randomly walked round the estate with a laptop, playing appropriate clips at the locations we found ourselves in.

On the basis of this demonstration, curators saw that this approach, which deviated from a set route, worked in terms of delivering the information they valued. Over the course of the project, using various methods, curators were repeatedly exposed to new ways of thinking about how content could be used to construct novel forms of tours. These included, as we have seen, content being broken up into separate clips that could be accessed in different orders. Additionally, we demonstrated how content could be delivered by technology rather than people; how audio clips from several narrators with distinctive voices could be mixed to form a piece of content for a given location; and how visitors could explore locations in any order instead of following a fixed path. Exposure to these new approaches was always combined with open, reflective discussion in the workshop (cf. Ylirsiku and Vaajakallio, 2007).

These workshops culminated in a system and a demonstrator experience: the school fieldtrip. This itself worked as another such intervention and demonstration of the possibilities offered by the technology, enabling curators to imagine novel practices. There was clear value change over the course of curators' involvement, brought about by progressively coming to understand more about technical and functional possibilities, but also working with us to negotiate and align different values.

Figure 10. The fieldtrip. Left: children walking around with a PDA. Right: Exploring the grounds

3.3.3 Value alignment and value change

In working with curators and teachers on the Chawton House project, we brought our own set of values: that technology can do new things that can go beyond convention, and provide new forms of activity. The curators and teachers also brought theirs: that human involvement, information, supervision, and known methods are important. It was therefore of crucial importance to the project that potential conflicts between different sets of values could be resolved, and for our co-designers to be able to see that we cared about what they do, and that we were flexible. Thus, a big part of the co-design process concerned value alignment. As this happened, there was much value change. To support this we needed to make sure that the co-

design relationship was a respectful one which busy curators and teachers could feel was worth spending time on.

The curators made quite radical departures from existing practice, moving from human-guided tours along fixed routes to technology-based tours that had no fixed sequence and were not guided by humans. In addition, the teachers agreed to run a fieldtrip in which they did not supervise children and were only indirectly present through the devices' prompts to the children – a big departure from their conventional practice. These were due to the capacities of the technology, and also to our own values. However, the result was more than us 'persuading' our co-designers of our own values. During this process, values that had been lost in the crystallization of previous practices were rediscovered. Some of these had been mentioned earlier, but had not been integrated into their current practice.

For example, in the first workshop the curators resisted the idea of visitors choosing their own route, and emphasized communication of information. However, other values – wandering and wondering, curiosity, delight - had always been present at some level. In the first workshop, Alan explained the philosophy of the Open Landscape movement (the style of the garden): "*That's what the landscape architects were trying to do – it was to entice you to walk somewhere to look at what was beyond: 'Oh! Ooh! There's a little gap in the trees! What's that? What can I see beyond that?' And you go and investigate it*". Similar statements were made during the (recorded) tours in the second workshop.

Figure 11. Left: Curator enthusiastically showing us vistas and views while giving us a tour of the estate. Right: Children running off on their own with the mobile devices

These values were rediscovered as curators began to rethink their practices. In the third curator workshop, after experiencing our laptop demonstrator of location-related audio clips, Greg commented: "*Part of it is giving the visitor control, isn't it? And letting the landscape speak*". Following the school fieldtrip, we saw curators discussing radically new ideas, embracing the 'freedom' of children being able to go where they want, "*to work it out for themselves*" instead of being told everything. We interpret this as them becoming aware, again, of the value of curiosity, wandering and exploring, and seeing new ways of implementing these in activities. They began to imagine novel practices, such as creative writing workshops for adults at the estate.

The teachers also rediscovered a value: tailored teaching (i.e. specific teaching for a particular ability group), often difficult to implement at school. They noted that for the group of able writers that they had selected to take part, "*the experience was very beneficial. (…) It's given them an opportunity they deserved*". They comment that this is also an alternative to "*going round with a worksheet*", a "*new teaching strategy*", letting high-ability children go off on their own while nevertheless providing a sequence of carefully designed instructions.

The rediscovery of existing values was important in achieving meaningful involvement of our co-design partners. It prompted reflection on their previous work practices, intentions,

and aspirations. It generated excitement, and helped curators and teachers envision new practices which could integrate these rediscovered values. It is also evidence that the space of possibilities for technology-enabled visitor experiences had successfully been opened up for both groups. At the same time, the linking of these values with new technology possibilities is an indicator that we left resources of future value.

Key here was a change from the view of visitors as attentive individuals who are provided with the correct information, to active contributors who generate content and record their own thoughts. The school fieldtrip demonstrated that visitors can make their own sense of the estate and respond to it in ways which are broader, richer and less predictable than may previously been envisaged by curators. When a researcher in one of the final workshops mentioned the possibility of the system to provide larger amounts of content to visitors, a curator objected that this would be the same as "*picking up a headset and cord […]. It's still passive isn't it*". Curators' ideas of visitor experiences and what 'engaging visitors' can mean changed markedly towards a view of visitors taking "*an active part*" and "*contributing to the experience*", which would make them "*feel they're more part of it rather than just being told things*".

Stakeholder buy-in and value alignment were extremely important given that both groups - curators and teachers - are busy professionals (cf. Cederman-Haysom and Brereton, 2004). Even a two-hour workshop represents a significant time investment. This meant that our engagement needed to be carefully staged and effort for participants minimized. In an open design space, where the outcome of the involvement is unclear, our partners' willingness to engage in co-design requires the establishment of trust, mutual understanding, and the realization of value.

We attempted to establish this in several different ways. For example, on top of our engagement with curators and teachers, we observed visitors on several occasions, and informally interviewed diverse staff members. This enabled us not only to become 'informed discussants' - it also demonstrated our interest in Chawton House. Asking curators to give tours to us in the second workshop provided them with an opportunity to demonstrate their skills and to 'enthuse' us, giving them the feeling that we acknowledge and respect this skill. As our co-designers came to feel that we shared genuine interest in the estate (constituting a shared value), their willingness to engage with us increased.

Similarly, we had assumed that content would need to be scripted and read aloud carefully, potentially by professional actors. But when we listened to the recordings of the tours that curators had given to us, we came to realize the authority, humour and energy of the curators' talk. This resulted in the idea of using authentic content from curators as audio clips for the technology-supported tours. The resulting system thus serves the value of honouring the enthusiasm as well as the skills of curators, and allows visitors to experience this skill in their absence.

Figure 12. The authoring device used while walking through the grounds

Another example of value alignment and mutual trust was the role of the authoring tool (see Weal *et al*, 2006) and how this should be designed. Here, we learned from curators and

teachers in unanticipated ways. While the design of a tool to support user-authoring of visitor experiences had been one of the underlying aims for the project, our visions for such a tool had largely focussed on how users might define logical connections between particular items. In fact, only a small subset of such logical conditions was needed (and manageable by users). Instead, it turned out to be essential for curators and teachers to be able to author content while walking around the gardens, since ideas for things to talk about or potential activities for children were triggered by being there, seeing and experiencing the location. Something we had not anticipated was the introduction of timings and delays in order to allow visitors to feel free, to follow their own impulses, and to take in their surroundings. This was only revealed through 'walking' the tour being authored. Thus, only through close engagement with both curators and teachers as well as actual deployment did we become aware of the importance for situated authoring.

3.3.4 Discussion

This longer-term engagement provided us with a richer picture of the role of values in a co-design process. What we had found in the Domestic Technologies and SensorPlay projects was also found in this project with a longer period of engagement with participants. Crucial here, in addition to values emerging whether or not we look for them, was the relationship between values and the evolving technology and activities. The project showed how values can drive co-design ideas that change an activity, revealing further values as that activity changes. In this process there can be value-change, value conflict and resolution, and the recovery of values that were held but remained latent. Thus, this project shows that there is a dynamic relationship between values, technology, activity and co-design.

The Chawton House project shows that the co-design process – how it is managed, and what is designed – crucially depends on values. Negotiated agreement on values is essential, and this led to insights and value change on both sides; our participants, and ourselves, which drove the project in new and unpredictable directions.

We saw that as our prototypes and demonstrators were co-designed, shown and discussed, values changed. This suggests that values attach to activities. As activities change, so may values. However, in this project, activity change was a result of technological reconfiguration. Realizing what technology can do can change values not only in relation to the activity, but also to the technology itself: it leads to greater understanding and more sophisticated engagement.

Thus, on this project, a cycle developed: of expressing and discussing values, producing a prototype, assessing whether and how it reflects those values, and - in this process - expressing new values or uncovering forgotten values. A striking aspect of this cycle was that the representation of values by the technology drove understandings of how the technology worked (technological) and what it could do (functional) as well as creative ideas, which at the beginning of the process were beyond the curators' or the teachers' reach. However, it was noticeable that despite the development of such understandings, users cared less about the technology, than about what values it reflects, supports, or provides.

This project also revealed that in a longer-term co-design process there is an ongoing need for negotiated alignment of values between researchers and users. We had to negotiate our own values with the participants, and it was vital to the project relationship that they felt we shared some of their values, for them to invest in this project despite its unknown outcome. For partners to engage in a co-design effort requires the establishment of trust, mutual understanding, and the realization of value.

Thus, values were a key dimension of the Chawton House project. Working with values had important impacts. Curators moved from scepticism about the technology to excitement about it; from believing that only humans can give interesting tours, to the view that technology can support tours too; from favouring guided tours to more open arrangements; from commitment to a 'standard' tour to openness to many different kinds; and from a view of visitors as passive recipients to active contributors. In the process they redefined their own

roles and practices as curators, and changed the ways they conceived of and delivered user experiences.

4 Conclusion

When technologies built on the basis of values are integrated into an activity and this activity is engaged in by users, there are two effects. First, the activity is revealed and new values emerge. Thus, rather than seeding or driving the activity from a static point (Petersen *et al*, 2004; Voida and Mynatt, 2005; Friedman, 2004; Cockton, 2006, 2008), there appears to be a dynamic relationship between values, technology, activities and co-design. Second, the long-term value that Cockton (2006, 2008) recognises is supported, as well as participant buy-in throughout the process. This implies that there is more importance to values than just high-level orientation or seeding of ideas; there is more complexity as they do not stay fixed as co-design processes establish new ways of doing things; and there is more value in values as a design resource than has been recognised. Here, we summarise this.

Values that emerge when we take a data-driven, user-engagement approach have a clear relationship with the co-design of ubiquitous computing, especially when exploring new possibilities rather than problem solving. Often it was less the design ideas as products per se that were interesting as an outcome of ideation sessions, but the values that these expressed. In common with others (Sanders, 2005), we found that from the ideas and sketches generated we can identify values and concerns of our participants that point us to potential application areas worthy of exploration. This can enable us to develop ubiquitous computing applications that are useful and valuable for people, while reaching out into the opportunity space instead of reaching for a narrow solution to a well-known problem or referring to a stereotype. Then we can reconsider what is important in terms of application ideas.

At the same time, values can change: this suggests that co-design around values is not simply a question of identifying values and then designing for them, but a process which reformulates values. Engaging in a process through which people uncover and explore their own values enables them to rethink their practices. Ideas for products that can work within a specific ecology of human life are motivated by values and concerns of the inhabitants of this ecology, and these can be rich, varied and complex. Enlisting our design partners' engagement in a longer-term design effort requires that the engagement is meaningful and this is especially important when asking people for time and commitment. By uncovering and identifying values we start to identify a problem space that users feel is worth tackling.

These observations reflect the need for a co-design approach that, as well as making use of pre-selected values, also integrates values that emerge during the process. Some of the approaches reported in the literature start with values or value taxonomies that users are confronted with, or with designers deciding on a set of values to support upfront. We found that our design partners implicitly expressed values, not labelling them as such, but expressing something about what they care about and find important. These values are less abstract than taxonomies, and more concrete and practical, being based in real situations and conflicts. Thus, key to our approach is that values are situated, specific and dynamic - as well as the recognition of the need to work with this.

In co-design, users do not just help researchers with their agenda. Effective co-design results in a re-aligning of values. The Domestic and the SensorPlay projects both put into question unspoken assumptions and implicit values behind common ubiquitous computing scenarios that we were originally not very aware of. We came to realize the relevance of a completely different set of values, unearthed from the designs our users came up with or from what we heard and saw from them. This re-alignment also took place with the Chawton House project.

In addition, values do not have to be coherent. What people regard as valuable can be subtly or completely contradictory. Values can change wholesale, or in their relative level of

importance, when users start to take on board new technology concepts and new kinds of technology-supported activity.

Our research confirms that as well as being at cultural levels of granularity, or unconscious, values are also personal, and specific (as well as local) to the activities of participants. The importance of this (cf. Petersen *et al*. 2004; Ylirisku, Vaajakallio and Buur, 2007) is to convince us that design needs to be for values; but also, that engaging with values is a level of abstraction people comfortably work with, as well as being an invaluable resource in the forming of co-design relationships and framing and direction of the process. We came to deliberately look for and work with partners' values as a design resource, and found that this was at least as important as the specific methods that were being used. Across all three projects regardless of setting or whether adults or children, we found that, apart from young children, values are spontaneously expressed and of importance for co-design. That this finding applies across three very different projects indicates a wide envelope of relevance.

We have shown how values emerge during co-design work whether or not we look for them. In addition, there is value evolution: values can change and even conflict as the design process unfolds. This bottom-up, data-driven approach to value identification can provide leverage in solving a number of practical co-design problems as the process unfolds: as well as focussing design activity relevant to our users, it can help with the alignment of values between researchers and users, supporting the design relationship; help users understand and contribute at functional and technical levels; lead to user insight about their own values; and enable the expression of values both during the design process and, ultimately, in the designed artefact.

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