UbiComp in Opportunity Spaces: Challenges for Participatory Design

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ABSTRACT

The rise of ubiquitous computing (UbiComp), where pervasive, wireless and disappearing technologies offer hitherto unavailable means of supporting activity, increasingly opens up 'opportunity spaces'. These are spaces where there is no urgent problem to be solved, but much potential to augment and enhance practice in new ways. Based on our experience of co-designing novel user experiences for visitors to an English country estate, we discuss challenges for PD in such an opportunity space. Key amongst these are how to build a working relationship of value when there are no urgent requirements; how to understand and scope the space of opportunities; and how to leave users with new resources of value to them.

Author Keywords

Participatory Design, ubiquitous computing, case study.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI).

INTRODUCTION

Ubiquitous computing (UbiComp) is a new genre of technology, enabling new forms of interaction. Wireless, pervasive, and mobile computing allow interactions between devices, people and the environment to take place anytime, anywhere. Although one might argue that with mobile phones and PDAs we already live with UbiComp, this is still far from Weiser's [19] original vision of an environment filled with multiple, integrated, easy-to-use technologies. Integrating this vision of numerous sensors and interacting devices into everyday use contexts is still a major challenge. There is much interest in what specific value UbiComp can offer to users. To help ensure that systems fit their use contexts, and enhance their daily lives, we need to engage with users in design. Yet thus far, there has been relatively little involvement of users in the development of UbiComp systems throughout the design process. In recent years, a range of projects have explored how to employ UbiComp technologies in novel types of 'user experiences', e.g. augmenting public spaces for mixed reality games and learning activities [4, 7, 10, 11, 17]. Most of these endeavours follow a designer-led User-Centred Design approach, where the technology and the activity are created by researchers, and iterated over several use trials. Participatory design of UbiComp systems, which involves users right from the start, is relatively rare (for exceptions, see [1, 6]). A big issue is how we can help users design these intrinsically complex and relatively unfamiliar systems. While some recent projects have attempted to put configuration into the hands of users [16], there is still much work to do on integrating PD with UbiComp.

In this paper we report on a project, which involved the creation of novel 'visitor experiences' at an historic country estate, Chawton House, in Hampshire, UK. Chawton House welcomes a variety of visitors, such as academics, literary societies, groups interested in botany or in landscape architecture, or school classes using the grounds for curriculum-based activities. When approached by us, the staff of Chawton House expressed interest in working with us to create new kinds of technology-supported tours of the grounds. However, this was not in response to any urgent problem: there are already effective practices in place for giving tours. Thus, our remit was to create new kinds of practice based not only on novel technology that could be put together in a number of ways, but also a very open, unspecified space of possibilities in terms of the activities the technology would support. Rather than a problem space, this was an *opportunity space* – a space where many new things are possible but there is no clear requirement.

Early on, we agreed with Chawton House staff that we would work with a core set of staff members to explore the notion of different, specialized 'experiences' for specific visitor groups. There would be an archive of 'content', i.e.

text and audio media, about the grounds. This archive could be accessed and customized in different ways for different visitor groups, depending on what they were interested in, for example garden planting or the relationship of the house with literature. Visitor groups could furthermore be given tools and resources to help them design the kind of tour or activity they would like. This concept introduces three sets of stakeholders: Chawton House; the visitor group (be this an interest group, club or school); and ourselves as researchers. To demonstrate the concept, we agreed to create an activity for Year 5 (age 10) schoolchildren: a UbiComp-supported exploration of the grounds in support of creative writing. Thus, as well as the curators of Chawton House, we involved teachers from Whiteley Primary School, Hampshire from the start.

Our attempt to create novel UbiComp-supported 'visitor experiences' at Chawton House generated a number of challenges. Key amongst these, and discussed in this paper are: (1) How to create effective working relationships with users in an opportunity space where there is no 'problem' to be solved and no urgent requirements; (2) How, in partnership, to scope, define and work productively within the space of opportunities, both in terms of activities and technology, in a way that supports this relationship; (3) How to mediate and manage stakeholder relationships given more than one set of stakeholders, particularly when relationships change over time, and (4) How to leave our users with new resources of value to them for the future.

We now describe the project aims and introduce our partners, Chawton House and Whiteley School. We then discuss related work. We go on to describe the design process, and analyze our experiences of doing participatory design of UbiComp in an opportunity space.

THE CHAWTON HOUSE PROJECT

Project Overview
The overarching aim of the (ongoing) Chawton House project is to develop novel types of 'visitor experiences' of the estate (to be precise, one cannot create experience itself, only the activity and conditions within which experience happens). The project vision entails a ubiquitous computing system that enables visitors to explore the grounds on their own, while tapping into the knowledge held by curators. This should go beyond the now-common audio-tours that can be experienced at many museums and historic sites. We aimed to build a 'persistent infrastructure' for use and adaptation by various groups of visitors. By 'persistent', we mean that the technology remains in situ, at least partly maintained or changed by its users. This differs from a proof of concept demonstrator, which remains in system builders' hands, owned by them. For a system to be 'persistent' also implies ongoing use. This requires it to be meaningful and valuable to the people who will own it long-term (here Chawton House). We aimed to explore how to design such a system with the primary stakeholders, Chawton House, but also how to involve other stakeholders

in the design of specifically tailored experiences. Working with Whiteley School provided us with the opportunity to investigate the different kinds of requirements such further stakeholders might have. PD was thus an essential part of our project strategy, involving future owners in designing the system concept, and defining its aims. 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. In July 2005 a demonstrator experience took place: a fieldtrip for schoolchildren.

Although (as has been seen) involving users and stakeholders early-on in setting the design goals was regarded as essential, a rough project agenda had already been set. While some of the main project goals required involvement of stakeholders, others tended to predefine the design space. The latter refers both to the specific location - the grounds, rather than the house; and to the specific technologies, and technical expertise, that were available. Nonetheless, an initial design vision is a major impetus for any design project, in particular when it is to explore new possibilities rather than solve a problem. Bounding the design space in this way, introducing new ideas and 'springboards' [1], can be a useful strategy to help users imagine new practices, and to foster creativity.

In terms of the tours to be designed, the curators were open to different possibilities, without having strong requirements or visions. Our suite of candidate technologies included portable devices (PDAs) with a location-sensing infrastructure provided by a GPS network augmented by RFID beacons. Our design vision was to have visitors walking with a portable device, which would primarily deliver audio according to the current location and, in more dynamic arrangements, to previously visited places. As we initially knew little about curators' work practices, we did not know whether our ideas would fit in with their ideas and practices. Therefore, the precise deployment of these technologies and the kinds of experience they would deliver was open, and to be defined during the co-design process.

Chawton House: context
Chawton House is an historic English country estate dating back to the 15th century. The house is known principally because it belonged to the novelist Jane Austen's brother, Edward Knight. It provides a good example of a manor house with a large garden in the Open Landscape style. Its core function is to host a library and study centre on early English women's writing. Other activities include hosting day conferences, and cultural events. In recent years, Chawton House has increasingly attracted visitors with interest in English manor houses and gardens, which are admitted in groups on appointment basis. Chawton House does not see itself as a 'museum', as one curator emphasizes: "It's a living, breathing house, it's not a museum". Although the term 'curator' is therefore not totally accurate, we use it here for convenience. Several staff members give tours of the house and grounds, but this is not their primary

responsibility. Thus time and resources for offering tours are limited. This provided an opportunity for technology support. The curators that we worked with include Greg, the acting director; Sue; the librarian; and Alan, the estate manager (names have been changed). Of these three, Alan and Sue give tours, and Greg is knowledgeable on this.

Whiteley School: context
Whiteley School is a primary school in Hampshire, UK (age groups 5-11). It has a project-based teaching style, features an open learning environment, integrates ICT into many subjects and offers a broad range of extra-curricular activities. The teachers were interested in creating an educational experience for Year 5 children to support children's literacy skills by providing input to a creative writing exercise. The children would engage with the environment and write stories, using Chawton House as inspiration for characters, events, and setting.

The teachers taking part in our project were Pam, head teacher; and Leila, deputy head teacher, also responsible for literacy in all Hampshire primary schools. To design the augmented fieldtrip, they needed to understand what Chawton House could offer them, and how they could tailor it to their needs, as well as what the system itself could do. Our engagement with curators thus had to be carefully coordinated with our engagement with the Whiteley School teachers. Some of the co-design activities with curators had to take part prior to those with Whiteley, as they would inform the latter. At the same time, Whiteley School already have established practices around fieldtrips. Thus teachers had to recast this practice in light of the new technological opportunities rather than the more open re-envisioning that the curators were involved in.

We did not involve children in co-design. The main reason is simply that the school fieldtrip was to provide an example of other stakeholders utilizing Chawton House to create experiences for specific visitor groups. It is teachers rather than children who design fieldtrips, and our aim was to assist teachers in creating a specialized 'experience', thereby learning about requirements of external 'users' of Chawton House. A future option, though, may be to involve the actual end-users (in this case the children) in developing activities and working directly with visitor groups.

BACKGROUND AND RELATED LITERATURE
Our project shares aims with other projects that augment the grounds of an historic site for new 'visitor experiences' e.g. digital tour guides or technology-supported treasure hunts [4, 11], and with previous 'augmented fieldtrips' [3, 17]. Museum experts know that a major problem with digital tour guides is their upkeep – many systems quickly grow out of date as any changes or additions are cumbersome. We therefore aimed at providing infrastructure, seeding it with a valuable co-designed visitor activity, and making it extensible and persistent so that curators are supported in tending and authoring content.

Aiming at a system that is tended and extended by its owners relates to the concept of 'design in use' (or ongoing design) where the development of a system does not stop when it is put to use [8, 14]. Both the use context and the system continue to evolve as the system is appropriated. Systems thus need to be developed so as to allow for adaptation. This raises questions regarding the kinds of changes that users can achieve, the role of system administrators, infrastructure and ease of maintenance. System development is not so much the challenge, as its integration with work practice. An approach is to enable users to rapidly assemble and configure the system (cf. [16]), while IT specialists care for the infrastructure and provide tools. While long-term adaptation of the system by Chawton House is a goal of our project, the very notion of enabling 'design in use' implies involving users from the start and users seeing a benefit from being involved.

Participatory Design involves the challenge of assisting users in moving from reflecting on current practice to transcending it [2, 15], and supporting users' understanding of new technologies. Promoting users' understanding of UbiComp technologies is a major challenge, not only due to the technology, but also because it allows for the creation of radically novel practices. A range of approaches has been developed to support users in proceeding from current understanding to new concepts. These include future workshops and envisionment workshops [15, 9], and hands-on activities that let users experience new ideas and enact activities [1, 2] with models and maps or in the real use context. Other approaches that focus on UbiComp technologies include 'participatory bootstrapping', which lets users try out the technology to explore possibilities [6], or 'breaching experiments' [7], which allow for the *ad-hoc* creation of new practices, revealing possibilities. However, an understanding of the capabilities of new technologies and envisioning of new practices need time, requiring an iterative process that combines a diversity of methods with different foci, and that combines continuity with carefully planned disturbances or 'springboards' for rethinking [1, 5].

A crucial point that it is often more or less assumed, is that people both want, and are able to, engage with us in co-design. Where there is no problem space but rather an opportunity space, and especially given novel technology, users may not have the time, the motivation, or the understanding to contribute. In such a context, what does taking PD seriously entail? For us it meant that we needed to help create value without imposing too strong an agenda, to promote understanding, and to demonstrate value such that users would want to contribute.

THE PARTICIPATORY DESIGN PROCESS
In this section we describe how our own relationship with our co-design partners evolved and changed over time; how we mediated and managed the relationships between stakeholders; and how we scoped the opportunity space in partnership with the stakeholders. This is organized around

discussion of our engagement with Chawton House and Whiteley School, which consisted of a range of activities over time, as shown in Table 1 (below). We carried out interviews, both structured and unstructured, throughout the process. All activities were videotaped and to a large extent transcribed. The discussion that follows is based on iterative qualitative analysis of transcriptions and video.

Date (2005)	Location	Activity
11.03	Chawton House	Informal meeting at Chawton House, tour observation
19.04	Chawton House	First curator workshop
20.04	University of Southampton	First teacher workshop
03.05	Chawton House	Second curator workshop: curators give tours to researchers
18.05	Whiteley School	Second teacher workshop
25.05	Chawton House	Observation of a Floral Society house and garden tour
26.05	Chawton House	Third curator workshop
03.06	Chawton House	Third teacher workshop
27.06; 04.07	Chawton House	System trials on site
12.07	Chawton House	Literacy fieldtrip
13.07	Whiteley School	Story writing
02.09	Chawton House	Fourth curator workshop

Table 1: Sequence of activities

Our engagement with the stakeholders differed in terms of the opportunity space explored with each group, leading to different relationships and design processes. With curators we were exploring possibilities for novel visitor experiences that transcended current practice, while with teachers we were designing one specific visitor experience, based on the existing practice of fieldtrips. The fieldtrip indirectly was to provide a demonstrator supporting the long-term co-design effort, by bootstrapping curators' understanding of the potential of the system for new types of visitor activities. Furthermore the project required us to carefully manage the sequencing of workshops to create a working relationship between the two partner groups. This relationship started out being mediated by us, as we were still exploring how the design process could work and wanted to reduce uncertainty for our design partners. The fieldtrip finally integrated results and efforts from all sides.

Participatory Design Activities

First curator workshop
The first curator workshop had three aims: to understand curators' current practices, to find out what kinds of things they tell visitors about the grounds, and to discuss possible sorts of tours for visitors. Inspired by the use of maps and small-scale models in PD [1], we printed a large map and populated it with models of buildings that grounded discussion and supported curators in explaining the grounds to the research team. The workshop provided us with an initial understanding of curators' practices and initiated discussions about current practices, about issues that a

guide system could help to address, and provided curators with a beginning understanding of our design vision.

The first curator workshop raised a number of issues in terms of building a relationship, scoping the space of possibilities in the absence of a problem, and mediating between Chawton House and Whiteley School. Originally we had wanted to record some of the stories visitors are told, but we found that curators were not used to telling stories when not on location. This reflects that at the beginning of the design relationship we made assumptions about practice that we needed to revise, an example of us needing to learn from them to understand their practice. Conversely, our ideas about the system were necessarily unspecified. Following a suggestion from Alan, it was decided to use the next workshop with curators to record actual tours, thereby generating content, which could be used by the teachers. Alan said: "the best way to capture the basic info (...) is to actually follow round with a tour, and record that, and then you will actually get the little snippets. (...) And that is your basic tour. And then to add to it, the easiest way to do that is to film it, to record it, and somehow get that into the system".

First teacher workshop
During the first workshop with teachers we designed a rough structure for a fieldtrip, using the same map as before to help teachers remember the features of the grounds (which they had visited earlier). The workshop gave us insight into how teachers design fieldtrips, their educational value, and how they are organized. The map focussed discussion about the event's structure and general orchestration. It was decided to have three phases, starting with a tour of the house by a curator. Then the children would explore the grounds freely, and in a third phase focus on two locations and start to conceptualize stories. The teachers were interested in using historical characters to inspire children, letting them meet these characters (audio voices), who tell about their lives, while exploring the grounds. These ideas provided us with requirements and questions to take to the curators for the next workshop.

It became apparent at this point that the co-design challenges were not uniform across the two sets of stakeholders. The space of possibilities for the curators of Chawton House, considering completely new ways of giving tours, was much less constrained than that for the teachers, who were specifically working with how to introduce technology into an existing practice, fieldtrips. The relationship with each group would thus be different. Further implications concerned the mediation of their relationship and the scoping of the opportunity space. For the first teacher workshop, we had hoped to have some content generated by curators for the teachers to work with, but this had not yet been generated. The fact that we had only a rough overview meant that constraints were not clearly defined, such that the teachers could come up with the notion of meeting historical characters. For future workshops we were concerned to carefully manage the sequencing of workshops, collecting, summarizing and

processing results so that they could inform the next meeting with both groups, mediating between co-design partners, mutually scoping the opportunity space.

Second curator workshop
During this second workshop, Sue, Alan and Greg each took a pair of researchers on separate guided tours, which we videotaped. Through this experience, together with our prior observations of other tours (see Table 1), as well as talking with the curators, we came to see how the curators' creation of visitor experiences of Chawton House is a skilled, dynamic, situated and responsive activity, a form of improvisation triggered by locations, artefacts and visitors' responses and questions. This revealed more about how tours are actually conducted than the reflection on the activity which we had tried to encourage in the first curator workshop: Working with curators taught us that they can only authentically tell stories when in the grounds. What we also discovered was that curators often refer to and deliver a 'standard tour'. Although this is never precisely the same twice, it involves a given route around the house and garden, with the reappearance of anecdotes in locations. It also became apparent that curators enjoy 'enthusing' visitors and look to achieve this.

This workshop also changed the nature of our relationship with the curators. There was a strong sense that the curators felt that we were working together more effectively at this point i.e. what we needed to know about was being discovered and this was best use of time. They had the opportunity to demonstrate their skill to us and 'enthuse' us, giving them the feeling that we acknowledge and honour this skill. This is reflected by Alan after the fieldtrip commenting on this workshop as a success: "it went very well".

An aim of this workshop was to elicit the content for use in tours that we had been unable to get during the first curator workshop. Following review and analysis of the recordings, we were struck by the authority, humour and energy of the curators' talk, and provisionally decided to use these 'authentic' audio segments in tours, given curators' agreement. Additionally, it would be simple and natural for them to extend the content base by taping tours, selecting sections, building an oral archive of knowledge for their own and visitors' use which would leave them with a resource of value for the future. This approach would furthermore honour the skills of curators, and preserve these to be experienced by visitors.

Second teacher workshop
In the second teacher workshop, we had a set of audio clips that the teachers could use to develop their ideas. Again, we used the map to revisit the initial sketch of the fieldtrip. Being able to give an overview of curators' stories led to a redesign. We jointly decided that the content on historical characters would not engage the children's imagination. Yet some stories, e.g. about the adjacent church burning down, or 18th Century ladies pretending to be in a wilderness when walking through a managed woodland, could spark their imagination. It was decided to select short clips that provided historical or social context for the children's writing, and to use these in conjunction with instructions and prompts from teachers, that the system could display. The teachers used the map to place notes where events could happen and instructions be given. The fieldtrip structure was refined, thinking about the length of phases and types of activities for each. However, when it came to deciding on concrete activities and instructions, the teachers hesitated, as these would need to relate to concrete features of the grounds. It was therefore decided to meet for a third workshop on location.

A big issue in this second teacher workshop was the scoping of the opportunity space, i.e. establishing exactly what was possible. To promote teachers' understanding of the possibilities, we described, and showed pictures of, a set of technologies from a previous project [17] that were a candidate for this one: mobile devices with audio and text, capable of sensing location. Thus, this workshop implied increased commitment to this suite of technologies. The visit to the house we organized also implied commitment to the notion of location-driven instructions and activities.

Third curator workshop
Given the commitments we had tentatively made with teachers, we needed to get curators' agreement on using the selected 'authentic' audio clips, and to negotiate logistics for the fieldtrip, which involved curators' efforts. This workshop was important in preparing a more direct relationship between the two stakeholder groups. The workshop was further aimed at increasing curators' understanding of the technology and the sorts of activities that could be supported, and at exploring ways of dealing with and reusing the collected content for different types of visitor tours. We presented an example of a related system for school fieldtrips (used on another project [17]) by means of a video (the same system as explained to the

Figure 1: a) curators explaining map of the grounds; b) curators giving a tour; c) teachers thinking on fieldtrip structure; d) the fieldtrip

teachers). In addition, we went outside the house, playing selected audio clips in different locations from a laptop to give an impression of how visitors might experience these. Then we presented curators with the same clips transcribed onto separate cards. The aim of this exercise was to explore how audio clips might be re-organized in different ways and how they could be sorted according to topics addressed. We found that curators were mostly concerned with the correctness of stories, although they were happy that these could be used, and also to leave it to us to re-organize them. While this created work for us, it also showed that they trusted us to do it.

An important output in terms of our developing relationship with the curators was the level of ownership of the system. We came to understand that curators were not yet sure of what value the system could provide them with and thus were hesitant to invest effort. Although they were interested in our feedback on their practices, stating that it was "interesting to see what you pulled out [the audio clips], what you find interesting", the workshop revealed that the devised system was still seen as designed and 'owned' by researchers, indicated by Sue asking us: "once *you've* decided what *you* want to include" [our italics]. An important implication of this was that we aimed to increase curators' engagement with the fieldtrip, to demonstrate the potential value of the system and the scope of visitor experiences possible. The sense of ownership of the system is important: the system needed to be valued to become a resource for long-term use and development.

Third teacher workshop
The third workshop with teachers took place at Chawton House. We used this opportunity to introduce the teachers to the curator who would give a tour of the house on the day of the fieldtrip. Then we walked the grounds, the teachers brainstorming ideas for activities and instructions, assisted by us with background information and an overview of suitable audio clips. Back in the house, ideas were selected and refined, and timings planned for e.g. how long children should stay at a location and how instructions would be sequenced. Further collaboration via email concerned sharing notes, writing instructions, and refining the orchestration. The third teacher workshop, then, was focussed and bounded by teachers' direct experience of the location and what was possible in terms of the technology.

The system
During the workshop process and given the willingness of both sets of stakeholders to agree to our ideas about what technology was possible, we developed a system consisting of portable devices (iPaq PocketPCs) capable of delivering and recording audio and text. These PDAs, an arbitrary number of which could all be used at the same time, were linked to a location-sensing architecture consisting of GPS augmented by pingers (RF beacons). The content (audio clips, text instructions) was organised and delivered by means of an information architecture based on adaptive,

physical hypertext, which is sensitive to prior locations and content already received. Users could record audio and text messages ('annotations'). The system logged movements and annotations and the results could be accessed on the PDA and later by users on web logs. A fuller technical description of the system can be found in [18].

The literacy fieldtrip
The two-hour school fieldtrip took place four months after the project began. We invited curators to observe it, to provide them with direct experience of the system in use. Two curators were present on the day, observing and following the children. Six children, as well as the two teachers, came. First, Sue gave the children a guided tour of the house. Then the children explored the grounds in pairs, free to go wherever they wanted, and followed by researchers recording them. Each pair shared a PDA with location sensing (see [17]), and the ability to record audio and text. The device introduced the children to a location with audio clips. It then displayed a series of prompts designed to inspire children's imagination. For example, after listening to a clip about a location called 'The Wilderness', they were asked to explain the reason for this name in their own words, and instructed to find a 'spooky' spot and describe it. After this phase, children met with the teachers, decided on initial ideas for a story and two locations to focus on. Then they went to these places and were prompted by the system to conceptualize a story. The next day at school the children continued writing their stories. A fuller description and analysis of the fieldtrip can be found in [12].

Reflecting on the fieldtrip
Afterwards we interviewed the curators about their impressions and ideas, and asked for feedback on how the collaboration with us had developed. The curators were impressed by the fieldtrip and told us that they now had a better understanding of the technology and the possibilities for using it for visitor tours, finding it very promising because it liberated visitors from being walked "round a set route", and allowed flexibility (Sue). They could imagine Chawton House offering this to other visitors. Alan told us, "I think there is a huge potential there for people to get out of it what they want. And then it's not necessarily labour-intensive, is it?" He also said, "the concept I think is good and then it will obviously lead on to many other things, it can be developed and adapted".

This indicates that curators began to take ownership, but at the same time changed their views of what could happen in the future. In other words, the opportunity space began to crystallize in their minds as well as the possibility of further use, i.e. that we would leave them a 'persisting' system.

Fourth curator workshop
The aims of the fourth curator workshop were to give curators the opportunity to reflect on the event and to explore further options for novel visitor experiences. We presented a 30 minute summary video from the fieldtrip, some of the feedback from children and teachers on the

event from subsequent interviews, and showed them the stories written by children. Then we walked with them around the grounds, letting them use the device, experiencing similar activities within locations as the children had encountered. This experience sparked discussion of opportunities for novel experiences for other visitor groups who might be interested in literacy-related experiences; the involvement of visitors in creating content; and the future of the project.

Curators were interested in the topic of the fieldtrip (literacy), its outcome (Chawton House is a literature library), and its process. They emphasized how much the children had enjoyed the freedom to roam the grounds, allowing for discovery and excitement. Observing the children recording their own thoughts led to the notion of the 'active visitor' who "contributes to the experience", instead of only being delivered information, and had curators think whether this might also be of interest for older visitors. The workshop thus reinforced the change in perception that had been a result of the direct observation of the fieldtrip.

DISCUSSION

One of the concerns of our research is how to create an effective working relationship with stakeholders when dealing with an opportunity space, i.e. a space where there is no concrete demand or problem. Here, we reflect on the challenges of scoping an opportunity space with different stakeholders; helping our design partners to understand what the technology could provide them with; developing meaningful relationships with them; mediating their relationships; and leaving a result of value to them.

Different Stakeholders, Different Relationships

The opportunity spaces for our two stakeholders, Chawton House and Whiteley School, were not the same. This had effects on the relationships we built, the meaning of the work for the stakeholders, and how much work we needed to do to maintain each relationship. With curators we were exploring possibilities for novel visitor experiences that transcended current practice. In contrast, because they were building on existing practices, it was easier to design the fieldtrip with teachers, although it had a complex structure and required e.g. the sequencing of events, than to discuss and devise concepts for tours with the curators.

For both sets of stakeholders, there were also issues around understanding the technology. The curators tended to relate our technology to museum audio guides and wands that they had experienced elsewhere, but could not imagine how these might be used on the estate. We needed to ground understandings of what was possible in order for them to conceptualize alternatives, and this was crucial to scoping and understanding the opportunity space for them. Although the teachers worked with our assurances that certain things were possible (e.g. location sensing, appearance of instructions and clips) they explicitly said they were "insecure with the technology".

Issues of existing practice and UbiComp

Promoting users' understanding of UbiComp technologies is a challenge, not only due to the novelty of the technology, but also because it allows for the creation of novel practices. With mobile and distributed systems, it is very difficult to provide an adequate idea of how the system will work until it has been built. On the other hand, we did not wish to pre-empt the co-design process by presenting a system as a *fait accompli*. A risk of referring to prior experiences of tour guides is that this may limit participants' imagination. Prior to the fieldtrip, we tried a number of techniques to overcome this problem, none ideal. Showing videos of related systems did not provide actual experience and there were differences in application from their context. Walking around with a laptop to play clips in-situ had been partly successful. This had already required authoring of content and postproduction of clips. Playing clips on the actual device in the right order required large parts of the data to be defined and the infrastructure in place. Allowing users to experience the technology and from this to envision further options with UbiComp often means that researchers need to invest significant effort.

The fieldtrip provided stakeholders with a much clearer vision of what the new technology could provide them than any of our prior attempts. Sue told us in an interview directly after the fieldtrip: "It was nice to be able to see the system working. Not being technically minded, it didn't mean a great deal to me to begin with". Curators could see the fieldtrip as a template for other creative writing activities for a diverse range of visitors; they liked how visitors would be able to control the pace and order of a tour. Teachers similarly told us that "we were not quite sure about the technologies. And now we've seen them, and we've got a much better understanding". While designing the fieldtrip, they had at times been worried whether, "what you're writing down, would that actually work" and would it get the best out of the technology.

Our experience is similar to those of other researchers who address the issue of how to help users to conceptualize possibilities by letting them try out the technology, or create ad-hoc practices in real-life experiments so as to reveal possibilities [6, 7]. Our experience confirms that acquiring an understanding of the technology, and envisioning new practices requires time and cannot be rushed [1, 5]. For the curators, 'springboards' or 'disturbances' for rethinking were provided predominantly by the fieldtrip and the hands-on experience of the fourth curator workshop, and to some extent also through the audio segments and transcripts presented earlier. In [13] we analyze the process of evolving user understanding in more detail. As we will discuss now, readiness and openness to being exposed to disturbances relied on establishing a design relationship.

Trust and partnership

One of the crucial issues in doing participatory design in an opportunity space is that we feel it is our responsibility to ask stakeholders to participate in design, while we cannot promise a concrete outcome in advance, or solve problems.

Our partners' willingness to engage in co-design thus requires the establishment of trust, mutual understanding, and the realization of value. Creating a design relationship involves not only understanding the setting, but also concerns the more personal side of relationships, including caring about the same things. Our activities of observing visitors and interviewing diverse staff members, besides enabling us to become 'informed discussants', demonstrated our interest in their work. Having curators give tours to us in the second workshop seemed to be interpreted as us acknowledging and respecting their skills. As our co-designers came to feel that we shared genuine interest in the estate, their willingness to engage with us increased. Visiting teachers at the school in the second workshop not only relieved them from travelling, but also allowed them to host us, and feel in control of the situation. As the design goal for teachers was more focused, this eased the co-design process. Still, trust was a relevant issue, as teachers confessed to have felt somewhat uncomfortable at the start of the fieldtrip, explaining "you're conscious that you're responsible for those children the whole time, and you have thought of every eventuality, so by having the technology there, that isn't something I've got control over." They thus needed to trust the research team, who had more control of the system.

The work for us, and the work for them

In organizing workshops we had to be aware that for both groups even a two-hour workshop is a significant time investment. This meant that our engagement needed to be carefully staged and effort for participants minimized. Minimizing workload is also a requirement for designing 'experiences' (for example, scripting the fieldtrip).

For teachers and curators it was at times tedious to explain basics of their work practice to us. Yet for us this was indispensable, as an understanding of the setting was central for us to build something of value. This, together with the difficulties users had in envisaging the future technology required their patience in following us through workshops. On occasion the curators needed to educate us on what best to do. For example, in the first curator workshop, Alan advised us to record real tours, and commented that this would be the best way to add content "because otherwise it is a chore". He also strongly expressed the need to make best use of time. He had sometimes felt the workshops to be too open-ended, "wanting to say 'lets get to the nuts and bolts'" because "time is money and time is short". Teachers also emphasized this issue, the teachers expressing some reservations regarding the time dedicated to workshops. A clear message from Leila was that in preparing fieldtrips teachers expect to spend "half a day" visiting the place upfront and talking it through, plus "the odd half hour in school, just preparing for it". The cost/benefit issue meant that early on, we were doing a lot of the work to make the project happen: selecting audio clips, cutting and preprocessing them, transcribing them, summarizing discussion results, and putting the fieldtrip structure into a format that could be transformed into machine-readable form. It was important

that meetings were focussed, yielding discernable results. This at times conflicted with the experimental and explorative stance of the project, which required open-ended discussion and finding out 'what works'.

Mediating Stakeholder Relationships

A further example of the work we needed to do was mediating the stakeholder relationship. This required the careful managing and sequencing of workshops to make sure outputs from one were ready as input to the next. For example, audio clips of curators had to be ready for teachers for selection. Also, results of discussions on what one group thought it might need or the other felt they could provide, had to be transmitted. Our long-term aim was to create a system that would enable Chawton House to offer tools and resources to visitor groups, enabling the sorts of design contribution the teachers had engaged in. However, this is future work and we had to act as proxy here. Altogether though, there appears to have been some success: in some sense the final creation – the fieldtrip – turned out to be a shared one: The teachers produced questions, instructions and prompts displayed on the devices, and the audio clips generated by the curators acted as stimuli to be thought about. The fieldtrip itself, taking place in this form the first time, required orchestration efforts and participation from curators, teachers *and* researchers (technology support and mediation between stakeholders). Reflecting on the fieldtrip, we became aware how much this event was in fact the result of the collaboration of a large set of people: a multi-party orchestration. Thus, over time, the relationship between our design partners itself changed, them getting into more direct contact with each other. This reflects that the project aim of enabling visitor groups to create their own 'visitor experiences' on top of curators' content reconfigures the relationship between curators and visitors.

Changing Relationships

Our relationships with the stakeholders changed over time. In particular, both sets of stakeholders came to see the value of being involved in the project. As we worked together, we learned from the stakeholders, changing our practices, and both curators and teachers also changed their ideas and the process of working with us. Both sets of stakeholders, over time, became happier to dedicate time as they learned what was possible and value was realized.

Mutual learning and creation of value

An important factor for the project's success was mutual learning. From curators we learned a lot about the estate and their work practices, understanding what they care about. From teachers we learned about the practices around fieldtrips. The mutual learning taking place, which at times meant that our design partners had to educate us how to approach things best (like Alan in the first workshop telling us to tape actual tours), is reflected by Alan ironically saying there had been "a learning curve for everybody" when interviewed after the fieldtrip.

Although the first workshop was mostly successful in terms of us as researchers starting to understand the setting better, there were several instances of curators exchanging information or discussing issues that they had previously not done. The workshop thus provided an opportunity for them to build mutual understanding. In our data we can find several examples of how the engagement with us inspired them to rethink their practices. Reflecting on the observation that visitors often return after reaching a certain point, an idea is to have the device 'lure' visitors to go on with the prospect of a nice view. Another instance is when Greg reflects "one of the real attractions of this thing (...) the gardens are best experienced in solo or very small groups, whereas the house, it does not matter so much (...). The open spaces, there's a different feeling, where a more intimate personal approach; You might with a machine get a more personal approach, which is just you and the machine, rather than you and 14 others and a guide". This demonstrates how curators become open to the idea of a guide system and their imagination is stimulated.

This was strengthened in the third workshop. Greg commented early on about the engagement with us: "It's making us think as well. It's giving us very helpful ideas (...) but it's all relevant to the way we handle our work with visitors in general". The experience of walking around the grounds with us, playing selected audio clips, during the third workshop made curators realize that there could be a different choreography to their standard tour. Curators discuss the idea of putting readings of novel sections onto the device that take place at similar locations (such as a 'wilderness'). Reading transcripts of the selected audio recordings they saw what their colleagues talk about when giving tours, remarking on style and particular content, and found it interesting "to see what you [researchers] pulled out".

Rediscovering existing values
The changes in attitude and understanding on the part of both curators and teachers over time show how the space of possibilities had begun to be realized. The curators made quite radical departures from existing practice – tours that are not sequenced, not guided, etc. Teachers agreed to run a fieldtrip in which they did not supervise children – another big departure. In the process of opening up this space, values that had been lost in the crystallization of their previous practices were rediscovered.

In the first workshop the curators resisted the idea of visitors choosing their own routes. They favoured a set route, which would allow visitors to "pick up all the interesting bits of information as they go round". There is an emphasis on 'information' as the key reason for touring the gardens, without discussion of other kinds of user experience as e.g. exploration, wondering, reflecting, etc. However, these latter values had always been present at some level. In the first workshop, Alan explained the philosophy of the Open Landscape movement (the style the garden is built in): "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 curator workshop.

Rediscovery of these values emerged as curators began to rethink their practices. In the third curator workshop, Greg commented "part of it is giving the visitor control (...) 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, seeing new ways of implementing these in activities.

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 children go off on their own while nevertheless providing a sequence of carefully designed instructions.

The rediscovery of existing values was important in strengthening the relationship between ourselves and the stakeholders, and getting their buy-in. It is also evidence that the opportunity space had successfully been opened up for both sets of stakeholders. At the same time, the linking of these values with the new technology possibilities is an indicator that we left future resources of value.

CONCLUSION
In this paper we have described issues around engaging with users to co-design in an opportunity space, employing UbiComp technologies, in order to augment and enhance their practices and activities, without any given urgent problem. Success factors included building a relationship over time; iteration through a diversity of design activities; providing hands-on experience and a concrete example of a 'visitor experience' that was novel, and emerged out of mutual developing understandings over time; taking account of 'busy users'; mediating between stakeholders, slowly bringing them into a more direct relationship with each other; and, finally not being 'distanced' (objective) researchers, but truly engaging with the setting and caring about the same things as our co-design partners do.

The key challenge of this research was how to create a meaningful working relationship with stakeholders where people are time-pressured and the engagement is about re-envisioning and creatively imagining new things rather than solving present problems. Perhaps inevitably, such agendas are not likely to be top priority. However, this does not reduce the urgency of this type of initiative. New technologies offer novel and even radical new ways of delivering value to users, and techniques of engaging with users need to be developed in offer to deliver this value despite pressured contexts, in order to realize novelty rather

than recreate what is already known. While these are common challenges in open-ended PD projects, UbiComp technologies add complexity and novelty on top of this. Here, we have started to investigate what is involved.

In our case, engagement in PD was driven by researchers rather than participants, us having approached them offering novel technology. Participants may at first prefer the traditional design model of researchers creating something and handing it over to them for feedback, as this requires less time investment from them and they assume that researchers know the technology better. Even if we feel that it is a better approach, we cannot pressure users into co-design. In this situation it becomes essential that involvement with the project delivers value to the participants and requires negotiable effort. This means that researchers must be prepared to take over tedious tasks, enabling their partners to focus on the creative parts and on vision building. Workshops and other activities need to be focussed and limited, delivering useful outcomes both long- and short-term, while being sufficiently open to extend the ways that new possibilities can be imagined. To take PD seriously in opportunity spaces, we have to be reflective practitioners who carefully and continuously promote the value of user involvement to get progressive buy-in, against a background of developing understandings of user needs and practices and what is meaningful to them as these develop during the design process.

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