# Unfolding Understandings: Co-designing UbiComp In Situ, **Over Time**

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# ABSTRACT

A key challenge in co-designing UbiComp is that users may have limited understanding or experience of these technologies. While the value of situated co-design activities for promoting understanding is known, the role of time is less well researched. Here we describe and reflect on a range of co-design activities carried out with the curators of an historic English manor house to create novel visitor tours. We show how an ensemble of situated co-design activities over time led to the unfolding of user understanding around issues of content, technology and user experience, in turn leading to a progressive reimagining of practice. This points to the importance of time and variety of *in-situ* activities to help people engage as codesigners in creating novel UbiComp-enabled experiences.

# Author Keywords

Ubiquitous computing, co-design, in-situ methods, time, public spaces, user experience, tour guides.

# **ACM Classification Keywords**

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

# INTRODUCTION

Ubiquitous computing (UbiComp) is increasingly being used in physical spaces, both indoor and outdoor, to provide new kinds of user experience, e.g., in home environments [20], museums [12], school fieldtrips [21], and mixed reality games in public spaces [3, 9]. These experiences novel arrangements of wireless often involve infrastructures, computing components, handheld devices, location-sensitive information delivery and so on, all distributed and integrated with the spatial environment.

However, they tend to be one-off experiences rather than a familiar part of our everyday lives.

It has long been recognised in user-centred design (UCD) approaches, that to develop new user experiences we need to co-design them with users. UbiComp systems are no exception. However, there is often limited understanding of the way UbiComp systems work, how they behave and what can be done with them, in the environment for which they are designed [20, 8, 22]. This can impact participation in co-design. Key reasons for this include the novelty, complexity, and situatedness of UbiComp systems. 'Everyday' device-centric or screen-centric applications, such as the web, mobile phones, or PDAs, are now familiar to people. Being screen/device based, they also provide a clear design and interaction focus around which users and designers can reason and explore possibilities. In contrast, people have less experience of understanding or interacting with diverse ensembles of sensors, devices, actuators, digital information flows and wireless connectivity. The interactional or design foci are less clear, and the design space is significantly more open, than, e.g., for a new ecommerce website. This novelty and complexity raises issues concerning how such systems could be perceived as relevant to users' current practices, as well as how those practices could be changed, extended or enhanced. This is exacerbated by the fact that UbiComp systems only fully make sense in the spaces for which they are designed, and need to be experienced in action. While Wizard-of-Oz and video prototyping techniques, and others, can help, the relevance of other UCD techniques, such as paper prototyping or heuristic evaluation, can be questioned: the complexity and situatedness of UbiComp systems provides a basic difficulty for demonstrating the system to users before it has been built.

This paper looks at what is involved in promoting user understanding to inform co-design of novel UbiCompenabled experiences. We offer a case study of engagement with users as co-designers for new kinds of UbiCompsupported tours of the grounds of an historic English heritage and literary site, Chawton House. In particular, we consider what types of understandings are important, and how these can be unfolded over time, by means of an ensemble of different kinds of activity.

We report on work with the curators of Chawton House, over six months, to develop new experiences for visitors. Despite not being end users, i.e. the visitors who would experience the system, the curators were our primary users, for two reasons: first, designing the tours offered to visitors has always been the curators' job; and second (and related), the system was intended to be owned, maintained and adapted by curators on a long-term basis. Visitors were also involved, as will be seen. Thus there were two main sets of users. When we use the phrase 'user experience' throughout this paper, it refers to the end user group – visitors.

Our focus in this paper is not so much on the designs that resulted from the co-design process carried out with our primary users, the curators, but more on the development of user understandings that enabled it. To support the codesign process, we needed to promote understanding of three interrelated issues: the *content* delivered to visitors, i.e., explanations, stories, or anecdotes about the grounds; UbiComp technology and the opportunities it offers to deliver content in new ways; and, perhaps most importantly, user experience, i.e. what visitors will do and how they might respond. We trace curators' emerging understandings of these concepts and their relationships and how their understandings relate to the successive use of different methods over time. We draw out two important and interrelated aspects of this process: first, the situated nature of the co-design activities, which all took place in the environment for which the system was being designed; and second, a 'layering' of understanding, considering what insights support the development of further understandings. As part of this latter discussion we show that new conceptualisations of future user experiences emerged on a basis of prior understanding of content and technology.

The development of curators' understandings of content, technology and user experience strongly influenced the codesign effort, particularly their increasing ability to step outside their current practices and think in new ways. Over time, curators' ideas changed significantly, in a number of ways. They 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.

From here, we report on the background of our project and related literature. Then we describe the project setting and aims, introduce our co-design partners and give an overview of co-design activities. We then trace how understanding of the three key concepts of content, technology and user experience unfolded over time and how these relate to successive situated co-design activities. We close by critiquing and discussing the value of this '*in situ*, over-time' co-design approach for generating user understanding for co-designing UbiComp for other spaces.

# BACKGROUND

The Chawton House Project is an example of employing UbiComp in outdoor spaces for new user experiences. In these respects it is a continuation of previous research, particularly 'Ambient Wood' [21], a 'fieldtrip with a difference'. Ambient Wood used a variety of technologies in a woodland to support children's scientific enquiry into the ecology of this setting. Such an approach has proven valuable in providing new ways to experience and interact with outdoor environments, particularly in augmenting physical exploration of the space with digital information, enhancing users' ability to explore and find out about the space. Others projects have used UbiComp to reconfigure the user experience of outdoor spaces e.g., street games [11] and plant care [18].

Promoting users' understanding of UbiComp is a major challenge. A range of approaches have been developed to support this. These include e.g. future workshops [16], which may or may not be predicated on existing user practice, and 'breaching experiments' [9]: radical interventions, framed as experiments, which allow for the ad-hoc creation of new practices and thereby reveal new possibilities. This reflects that UbiComp is often about extending current practices. Other approaches have included assisting users in configuring networked applications in domestic environments through a jig-saw puzzle metaphor to connect devices and events [20], and the use of cartoons to generate UbiComp scenarios [22]. Other authors suggest that the integration of UbiComp technologies into existing work practices requires a form of 'participatory bootstrapping', letting users try out the technology and explore possibilities [8].

In addition, familiar co-design techniques can be co-opted for UbiComp. Co-design involves the challenge of how to assist users in moving from reflecting on current practice to transcending it [4, 16] and how to support users' understanding of new technologies. The literature on codesign reflects the importance of situated techniques in this process; co-design activities are carried out in the physical and social contexts of the activity to be supported. This literature offers a wide range of methods, which can focus on understanding existing practice, or on letting users experience new ideas to assist them in transcending that practice [4]. Users may be encouraged to be 'hands on', engaging with and enacting the activity. Some methods ask users to role-play envisioned activities employing the future technology in the actual use environment [15, 19]. Others build full-scale models or provide high-fidelity simulations, e.g. video-prototypes that users can evaluate [1, 10]. Representations of the environment, including models, maps and even board games, provide context and allow for

reflection by giving an abstracted view [17, 19]. Reflective conversations can also be supported by real artifacts or mock-ups that work as 'things to think with' [5]. However, developing an understanding of the capabilities of new technologies and envisioning new practices requires time. Situated methods are often part of an iterative process, over time combining a diversity of methods with different foci on understanding, envisioning, evaluating, brainstorming, reflecting, comparing, etc. (cf. [7]). Our work is dedicated to unpacking how combinations of situated activities ground users' understanding over time and how they complement and build upon each other.

At Chawton House we used a variety of methods, mixing 'hands-on' and 'reflective' activities. We worked with maps to ground discussions, had curators experience prototypes *in situ*, enacting how visitors to the estate would interact with the system, and ran a full-scale 'demonstrator' of the system in the grounds of Chawton House. None of this is new in itself. Our contribution lies in considering not so much the value of particular situated methods, but how combinations work over time, particularly in promoting key understandings as a basis for further co-design work.

# THE DESIGN RELATIONSHIP

Chawton House is an historic English country house associated with Jane Austen, the well-known 18<sup>th</sup> century English writer. Its core function is hosting a library of early English women's writing. In recent years it has attracted increasing numbers of visitors with more general interests in English manor houses and gardens: as well as inviting scholars to use their library, Chawton House staff now give tours, by request, of the house and grounds to a range of people including schoolchildren, students, and various societies and interest groups.

Chawton House staff were interested in working with us to explore the possibilities for new kinds of technologyenhanced tours of the grounds. We met and interacted with several of the (approximately 15) staff, mainly working with three key people: Greg, the acting director; Sue, the assistant librarian; and Alan, the estate manager (names changed). Of these, Alan and Sue give tours to visitors.

The curators were open to different possibilities for tours, without having strong requirements. We had a suite of candidate technologies in mind, as well as some related design concepts. These technologies included portable devices (PDAs) with a location-sensing infrastructure provided by GPS augmented by pingers (RF beacons). The devices can play audio clips and display text and images. They can also be used to record audio and store text. These 'annotations' are stored on a server. Thus we envisaged visitors walking with a portable device that would display text and pictures, and primarily deliver audio, enhancing their experience of the environment. This could be done in flexible ways according to, for example, what location a visitor is currently in, and previously visited locations. However, the devices can also be used without the location-

sensing infrastructure. The visitor would then rely on explicit directions. We refer to location-aware tours as 'dynamic' and non-location-aware tours as 'static'.

For this project we had a particular interest in the possibility of creating dynamic tours for Chawton House. However, initially we knew little about curators' work practices, particularly how they give tours, and whether and how far they would be open to our ideas. Therefore, the precise deployment of the technologies and the kinds of experience they would want to deliver was open, and to be defined during the co-design process.

# **CO-DESIGN ACTIVITIES**

As a first cut into the large space of possible visitor experiences we decided together with the curators to focus on two kinds of visitor experience: one for adult visitors; the other an educational experience for schoolchildren. We further decided to develop the educational experience as an early demonstrator to bootstrap the curators' understanding of what was possible, which we would then build on in the future when creating further visitor experiences.

# Methodology

We worked with Chawton House over a period of six months. Our co-design activities consisted of four workshops of about two hours each, which involved the three core staff members on all occasions apart from Alan's absence from the fourth. The workshops focused on understanding their work and the setting, developing ideas for visitor tours including the educational experience, and collecting material to be presented by the mobile devices. After the third workshop, the educational experience, a school fieldtrip designed in collaboration with teachers, took place. The fourth workshop focused on reflection on this experience, particularly how other kinds of visitor experience could be developed as part of our longer-term co-design relationship. We complemented the workshops and the fieldtrip with observations of tours both of the house and grounds, observations of the everyday functioning of the house, and interviews with staff.

Each of the four workshops consisted of a variety of activities, which were distributed across the workshops (see Table 1). These included working with maps, walking around the grounds, video presentations, discussions and interviews with curators, demonstrations of system prototypes, elicitation sessions on how curators give tours, and brainstorming and design of content and experiences.

All workshops and interviews were videotaped. Videos were logged to summarize activities and discussion issues, with key utterances selectively transcribed. About 35% of the footage has been transcribed. Logs and transcripts were used to index into video footage during video analysis by the research team. Logs and transcripts were furthermore used to trace which issues were introduced and discussed by individual participants and what triggered the uptake of these issues.

Workshop 1	Workshop 2	Workshop 3	School fieldtrip	Workshop 4
Introduction	Three tours in parallel by three curators to researchers	Introduction	Tour of the house to children (given by Sue)	Introduction
Storytelling around map; explaining grounds		View Ambient Wood video		View 30 minute video on school fieldtrip
		Discussion	Children do field trip in the grounds, two curators partly observing it (Sue, Greg)	Discussion
General discussion		Walk outside the house, playing audio clips on a laptop to demonstration possible user experience		Curators use the prototype with a 'static deck', walking around the ground for ca. 15 minutes
Introduce idea of different 'types of tours'; General discussion		Discussion		Discussion of possible user groups and types of experiences; further plans for project
		Reading and discussing 'stories' on cards	Individual interviews with curators	
		Discussion		

Table 1. Roadmap of Workshops and Activities.

#### Overview of workshops and fieldtrip

#### Workshop 1

This workshop took place in a meeting room in the house and had three main aims: to understand curators' current practices of engaging the public and of giving tours; to record the kinds of things they say about the grounds for possible re-use as content for our system; and to see how open they were to the idea of different sorts of tours for different types of visitors. We asked curators what they know about the house and grounds, what kinds of things they tell visitors when giving tours, and what themes are important for tours. Inspired by the use of maps and smallscale models in Participatory Design [17, 19], we printed a large map and populated it with models of buildings. The map provided a shared reference for discussion, enabling the curators to point out key locations and to tell us the things that are interesting about those locations.

#### Workshop 2

The aim of this workshop was to find out more about how curators give tours. Sue, Alan and Greg took three researchers on separate guided tours. A second researcher on each tour videotaped it. The tapes provided us with material for possible reuse in audio tours. This workshop delivered a wide range of stories in different voices and from different points of view that were richer than those collected in the first workshop. Following this workshop, a set of audio segments were selected and cut by the research team from the recordings. These were of sufficient quality and interest to be used as content for our system.

#### Workshop 3

In the third workshop our aims were to give a video demonstration of the kind of system we could build; to see whether curators were happy with the notion of using audio clips of their own voices as content for the system; to demonstrate how the audio clips might sound *in situ*; and to let them consider how audio clips might be re-organised and presented to different visitors. We showed curators a short video of the Ambient Wood project [21] to provide an impression both of the technology and the kinds of activities that can be created for children. We then took the curators on a walk around the grounds with a laptop, playing selected audio clips to give an impression of how visitors might experience this. After this activity, we returned to the house and presented curators with these and other audio clips transcribed onto separate cards and explored how this content could be put together in different ways to create different kinds of experiences.

#### School fieldtrip

The educational experience, a fieldtrip, was provided by Chawton House for Year Five students at Whiteley School, Hampshire (for further details, see [13]). The fieldtrip was designed with two teachers at the school and used audio clips generated by the curators. (A discussion of the codesign activities with the teachers, and how these complemented and informed the curator workshops, is beyond the scope of this paper. For details, see [14].) It was designed to support children's literacy skills by providing input to a creative writing exercise. The exercise involved children in writing a story, using Chawton House as inspiration to devise characters, events, and setting.

Six students, as well as the two teachers, came to the fieldtrip. It took around two hours and consisted of four phases. First, Sue gave a guided tour of the house to the whole group. Then the children explored the grounds in pairs, free to go wherever they wanted. They were followed by researchers recording what they did, but not by teachers. Each pair of children shared a single portable device with location sensing (for details, see [23]), and the ability to record audio and text. The device introduced the children to a location they had entered by playing audio clips. It then displayed a series of prompts designed to inspire children's imagination. For example, having arrived at a gravelled path, children would hear a clip about how these paths allowed 18<sup>th</sup> Century ladies to go for a morning walk without getting their long dresses wet from the dew. They were then asked to role-play a conversation between two ladies and to record it with their device. At other locations children were asked to record their own descriptions. After this exploratory phase, the entire group met with the

teachers. During this third phase, a feedback session, each pair decided on initial ideas for a story and two locations that could inform it. In the fourth phase they went to these locations and were prompted by the system to conceptualize their story. The recordings, which could be played back, were stored on a server. The next day at school the children used their handwritten notes, as well as the server-stored digital recordings, to continue writing their stories. Sue and Alan were present at the fieldtrip to observe the event, and interviewed afterwards about their impressions.

The fieldtrip was an example of reusing curators' content for the purposes of specific visitor experiences and making it work in new ways. In particular, the teachers produced questions, instructions and prompts that could be displayed on the portable devices. The audio clips generated by the curators, rather than telling the children the whole story, acted as stimuli to be thought about further. We hoped that this would bootstrap curators' understanding of the potential of the system for new visitor experiences to be built out of their existing practice.

# Workshop 4

The aims of Workshop 4 were to give curators the opportunity to reflect on the school fieldtrip, and to explore how we could continue working with them to devise other kinds of visitor experiences. We presented a 30 minute video (providing an overview of the fieldtrip itself and the subsequent writing activity), summarized feedback from teachers and children, and showed them the stories the children had written. Then the curators walked around the grounds, with the device and content used by the children. For this activity, unlike the fieldtrip, there was no location detection and thus no dynamic delivery of information. We used a 'static deck', the device giving directions of where to go next, after a set of instructions and information related to one location had been finished. Curators thus experienced approximately the same activities as children. Discussion then focused on other possibilities for visitor experiences, and the future of the project.

#### UNFOLDING UNDERSTANDINGS

In this section we analyse how curators' understanding developed *in situ* and over time as a result of this suite of activities. Our analysis is organised around the three key areas of content, technology and user experience. (cf. the key areas of discourse for co-design [17]: users' present activity, technological options and the new system).

#### Understandings of content

Our vision for visitor experiences for Chawton House involved not replacing human expertise and knowledge [14], but re-representing and delivering it in new ways, allowing visitors to explore the grounds on their own, following a given route or choosing an individual path. However, curators initially found it difficult to envision such practices, which essentially change their relations with visitors and with content, as well as the degree of control they can exert over the visitor experience. Over the course of the project, curators were repeatedly exposed to new ways of thinking about how content could be used to construct novel forms of tours. In particular, content being delivered by technology rather than humans; content being broken up into separate clips that could be shuffled, allowing visitors to follow flexible rather than fixed paths; and visiting locations in any order. Attitudes on these issues changed markedly over the course of curators' involvement in the project, from initial scepticism to being much more open to the possibilities. Here we trace how this happened.

#### Fixed and flexible tours

In Workshop 1, we asked curators to think of different kinds of tours of the grounds; particularly whether and how far they needed to be guided or whether visitors could go where they liked. About 50 minutes into the workshop, we asked "So how would you feel about people wandering wherever they wanted?" This met with clear statements about how tours are currently organized. The curators demonstrated their shared belief that it is best for visitors to stick to a predefined route. They emphasized that if this were changed, visitors might miss key points of the garden. Alan said, "people can do that, and some people do do it, but it's far better that they stick to the route, because they actually get to see all the interesting aspects of the gardens and grounds.". Curators also felt that the current order of locations was the best one. Greg said: "logically, you start, you go to the higher ground and then work down. You wouldn't do the tour in reverse, would you.".

These comments reflect a commitment do doing tours on fixed routes in fixed orders and a belief that their value lies in getting the right information across. That both Alan and Sue chose to follow their standard route when giving us a



Figure 1. Working with the space, over time: From left to right: Workshop 1, telling stories around a map; Workshop 2, videotaping a tour given to researchers; Workshop 3, reading transcripts of audio clips; Workshop 4, curators using the device .

tour of the grounds during Workshop 2, reflects how ingrained this practice is. However, doing this did not allow them to reflect on their practice. Rather than thinking 'out of the box' or imagining new ways of doing things, curators were repeating what they were used to. While being *in-situ*, it was recreating existing practice and not giving opportunity to reflect on it. Thus we became interested in how to integrate demonstrations of existing practice with opportunities for reflection.

Workshop 2 was useful however for eliciting stories about locations and we generated a large set of audio recordings that we cut into clips. An example follows:

The church, which Jane Austen knew, was replaced about the 1830s. And then towards the end of the 19th century, they decided to put a new boiler in for the heating system. The first time they fired it up, it burnt most of the church down, only parts of one wall remaining, some memorials. So the church that's here now, dates from 1871.

In Workshop 3, we wanted to show curators what these clips would sound like and how they could be used in the context of a tour. We walked with the three curators and a laptop to different locations in the grounds and played a few clips at places where visitors might hear them. As part of the demonstration, we started in a different place to where tours normally start. Later-on curators remarked that it was an intriguing idea to start tours at the gate, a different route to their usual one. The idea that routes could be varied began to be understood at this point.

The most important effect of playing sound clips while walking around was that this re-represented curators' own speech to them as audio clips in a (very basic) mock-up of the future system. The decoupling of their voices from the act of giving tours and its use in a different context allowed the curators to see how clips could be re-ordered and even delivered in other locations. In addition, they could see how there could be switching between curators' voices: clips drawn from different curators could be complementary. In the subsequent discussion back in the house, Greg said: "There's no sense of disruption going from one person to another or one location to another, it made sense", expressing that the mixture of speakers and some re-sequencing of clips was acceptable.

In the second hour of Workshop 3, the curators examined transcripts of audio clips. Looking through a collection of clips from the tour Alan had given us, each on its own card, Greg said: "I'm just going through Alan's. They are not in sequence. But each one stands alone. I'm not too sure whether there is anything wrong with this order, or a different order". He saw that each clip could stand on its own and that there was no major problem in rearranging them. This shows that the curators were starting to understand that there could be variable orders of locations. These insights led to agreement that the school experience could have the children moving more freely, picking up information in any order they chose.

After observing the children during the fieldtrip, the curators' attitudes concerning pre-defined tours and fixed choreographies had completely changed. Interviewed

directly after the fieldtrip, Alan commented: "The children were walking – sort of scurrying around. [We] would be interested, because if you can say to children, go off and they come back 2 or 3 hours later, you haven't spent that time doing that.". This emphasizes that Alan felt that the educational experience was a success, but also that he saw a direct benefit to Chawton House – reduction of workload. Sue emphasized this still more when comparing giving a garden tour with her observations of the children walking around freely, commenting on freedom from a set route (researchers' comments are prefixed by 'R', other comments by the initial of the participant):

- S But then, if you're going to give a garden tour, you're just walking people round it and you're walking round very specific routes, whereas this, I think this was so... flexible... like this like we got today, anywhere you walked, and it's just so liberating!
- R Why was that?
- S Rather than them being ground round a set route, and being told about the places you could find. And they all seemed to And they really enjoyed it.

In this section on insights around content we see a combination of 'hands-on' and reflective activities as central to curators' changing attitudes, in particular the recasting of their current practices in new forms. Playing audio clips around the grounds in Workshop 3 introduced an element of defamiliarization and decoupling from the situated activity out of which these clips originated, while offering a new situated experience. This created openness to variation of tours that prepared curators for understanding and appreciating the fieldtrip activity. Observing the children freely exploring the grounds provided a 'breaching experiment' [9] that gave a vision of new visitor experiences and demonstrated their potential value.

# Understandings of technology

An understanding of the technology was necessary to enable curators to productively engage in co-design. Relevant technical concepts were that content could be delivered based on location-sensing, and that dynamic and static decks (location-aware or not) could support different types of tours based upon the same content. We needed the curators to understand the static/dynamic difference, but also issues around potential latency of location-sensing. A device may be triggered some time after a location has been sensed, so that what reaches a user may be 'out of date'. This issue, called 'offset', has implications for how content can be used – i.e., highly location-dependent or time-critical information should be avoided - but also allows for creative ways of taking account of this effect, e.g. triggering curiosity or requiring a search.

Understandings of these concepts developed later in the process and were connected to experiencing or using the technology. Unsurprisingly, at the outset of the project curators framed what was possible in terms of their existing understandings of how tours are given, and in terms of their previous exposure to guide systems. The following section, focussing on curators' prior experiences with guide systems, shows how curators' understanding of the relationship of the technology to user experience developed in the context of the co-design activities we involved them in over time, including how as part of this process they came to understanding the static/dynamic and offset issues.

#### 'A step on from the wand'

Initially, Alan, Sue and Greg had knowledge of 'wands', i.e., slim rectangular audio guides with headphones used in various museum settings. Sue was also familiar with museum guides that require the user to enter numbers to hear about something. During workshops all parties referred to 'wands' used at other places. Alan and Greg also knew about GPS, i.e. location-sensing, in the context of car navigation systems. Sue appeared to have no knowledge of GPS. However, interviewed after the school fieldtrip, Sue showed a growing appreciation of how technology can change the user experience: "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; but to actually see it working, and to see how the technology had been integrated - with the tour of the historic house and the grounds, that was very interesting.".

Sue's understanding of the devices we used was initially strongly influenced by her previous experience of museum guide systems. By the time of this interview, this preconception had changed, and she felt that there was potential for much more flexibility: "I think when it first started I thought it was going to be along the lines of the ones that you often see people use at historic sites and museums... and then you press that number into the little keypad and it'll tell you something about the object at that point. So I thought perhaps it was going to be something like that. But I think this has probably got the potential to be a lot more flexible.".

Alan echoed Sue: what happened on the day of the fieldtrip differed to what he had experienced before and to what he was expecting: "People can walk around with their little handheld and can interact with things and can get more levels of information. But, I think, yeah, there is potential for it. The concept I think is good and then it will obviously lead on to many other things, won't it – it can be developed and be adapted.". When asked how it could 'lead on to other things'. he said: "It's a step on from the wand – it's making it intelligent, isn't it?". Both Sue and Alan realised that the technology used in the fieldtrip was different and more advanced from what they had previously experienced.

During Workshop 4, some weeks after the fieldtrip and the interviews discussed above, we reflected on the fieldtrip, and gave the curators a first-hand demonstration of the tour the children had experienced. When combined with this reenactment, curators' prior observation of the fieldtrip, together with the reflection prompted by the interviews, led to technology insights around the crucial issues we needed to ground: the static/dynamic distinction, and offset related to latency in location-sensing. The following section looks at what happened in Workshop 4 and refers back to the prior workshops where necessary.

#### Static/dynamic: support for fixed or flexible tours

The following vignette shows how an issue, when experienced *in situ*, and on the basis of prior understandings

and activities, is realized by curators. A tour demonstration involved curators in walking the grounds with the device that provided them with the same set of instructions and audio clips as the children had. During this demonstration, Sue used a 'static deck' that recreated the sequence of events from the schoolchildren's experience, while Greg and Kate (Greg's PA) looked on. The following sequence begins with Sue expressing a perceived mismatch with her observation of the children during the fieldtrip 'going in all directions' and her own experience during this walk. Following this, the researchers acknowledge her observation and explain it:

- S One thing though, it's gone in order, from the door to the library terrace, but the kids were going in all directions
- R1 Yeah, that's right.
- R2 That's because just now it's a static
- K Oh, you haven't got the boxes!
- R3 So each of the locations, when you get there, is how it would be, but then there's a card between each location so it says 'now move to', and so it's all sequenced, but
- S (nodding) right
- R2 instead of instructions, then, usually they would only get, once they are in a place, get a set of instructions in order, and then be free to go somewhere else, and then (group starts walking on)
- R1 and what they get depends on where they've moved to. But this is just structured.

Kate (K), who was only marginally involved in the codesign process, offers a central part of the explanation. The boxes – pinger points that she obviously noted as part of the setup for the school fieldtrip – are part of the location sensing infrastructure and they are missing now, thus the current setup is static. While the researchers explain, Sue acknowledges her understanding by saying 'right'. She then shows that she understands the static/dynamic distinction when she reveals that she realises that this has been a simplified simulation, enabling them to experience the system without it being dynamic (without location-sensing):

- S It's just to show how it works really, isn't it, yes.
- R2 Yeah
- R1 So that's new instructions, like 'go now to exactly this and this place'
- R3 Yes, this was our back-up plan, with none of the location sensing technology with it (laughter) And it's an alternative way of doing this type of system, so you can have a guided tour where people were to go next rather than
- S Yeah So you could set it up for either one of them.
- R3 Yes
- S Use the same information, just in a different...

In previous workshops Sue had hardly reacted to researchers' attempts to explain the technology. Now with her rephrasing she demonstrates a quite sophisticated understanding, that the same basic information (audio clips) can be reused for static or dynamic tours and that the system allows for both possibilities.

This section again demonstrates how situated activities can consolidate understanding and lead to insight in the context of a succession of activities in which one informs the next. While technical explanations given earlier did provide the background information, it was only at this point, after having seen the system working and using it herself, that Sue was able to develop her own understanding.

#### Offset: searching for the object referred to

As part of the same *in situ* activity, curators came to understand what offset means in terms of user experience and what implications it might have. The fact that information on the device might appear offset to its referent location had been mentioned by the researchers earlier on in this workshop, but not been taken up as an issue by the curators. It only became clear for the curators when experiencing it. Directly prior to the following transcript, Sue reads from the device, follows the instructions and walks to a location called the Library Terrace. She hears an audio clip, and then reads from the device:

S 'Notice the mill wheel in the floor. Think about the way it might be...'.-There. So you have to actually look for it... (moves towards the mill wheel while others follow) rather than, just be guided to it.

The curators are now enacting the children's activity and not observing it. They are actually doing the walking, and establishing references between audio clips, instructions and locations. Sue realises that searching is required and comments on this. Curators thus experience the tour from a visitor's perspective and are also able to reflect on it. Sue's comment is not negative, but matter-of-fact. That the system asks visitors to attend to their surroundings is perceived not as a system failure but an intriguing system feature. Later, Sue combines this insight with a new idea – she suggests that the system could support finding the mill wheel by showing a picture.

#### Understandings of user experience

Insights around user experience, and what kinds of visitor experiences can be created, depend on curators' understanding of content and technology issues. Here we trace the unfolding of understanding of user experience. A major issue here was how the tours that curators currently offer shaped how they conceptualize alternatives. We have seen how the notion of variable tours took time to emerge, and the work needed to generate this understanding. Curators' ideas of visitor experiences and what 'engaging visitors' can mean changed markedly through their own experience of the fieldtrip, towards a view of visitors taking "an active part" (a quote from Sue) in contributing to the experience, and the system fostering this in flexible ways.

Initially, curators were unsure about why visitors should want or be able to record material. This issue, that we called 'annotation', came to be seen as visitors 'contributing'. Initially, curators were mostly interested in expert visitors contributing with information about the estate. After observing the children, they saw that the system could allow visitors to work things out themselves, be in control of their activity and record their own thoughts. This understanding was key in curators' perception of the device changing over time. Initially this was seen in terms of audio guides as used in museums, but, again, this changed markedly as understanding increased.

# Changing views of visitor engagement

The following excerpts from Workshop 1 reflect a view of visitor experiences based in human interaction, where there is no clear place for technology:

- S You have a basic script, and then, as Alan was saying, depending on what sort of group you have, and how you react with them, you get clues from them what they're interested in, and you can talk more about that.
- A But a lot of it, we're talking about doing that, you're not having a person, are you, you're having some sort of device, machine, or whatever. But the way to give that life and feeling and give interest is probably to have someone talking, or have someone who's enthusing about something, isn't it. You can enthuse in text, but it's like you're saying in that hypertext thing, how do you capture that?
- S Because you can actually change the mood of a group, can't you; if you try and keep up-beat and enthusiastic, you can actually get the group to respond to you and start to feel that way too...
- S It comes down to body language, how we react to them, which is something you can't deal with in the technology, isn't it.

The curators regarded giving tours as mediated by humans and they were sceptical of what a device might be able to do. It is important to note, though, that this view was associated with a view of tours as predefined with fixed choreographies. As content and technology insights arose, this view of what the user experience could be like changed.

New ideas for visitor tours started to emerge when we showed the Ambient Wood video in Workshop 3. This provided the curators with an example of a related activity. One of the researchers initially explained the technology involved, and then the children's activities, emphasizing that they were investigating the scientific topic of ecology 'in context'. Sue and Alan nodded and said: "makes it come alive". This contrasts with Alan's comment in Workshop 1, see above), that "the way to give that life and feeling and give interest is probably to have someone talking". Now there is an appreciation that 'life' can also come from technological arrangements.

Workshop 3 also saw curators thinking more about letting any visitor, not just schoolchildren, explore the grounds more freely. This was prompted partly by their experience of walking outside the house listening to audio clips, and by browsing through those clips transcribed to cards. Interestingly, when a researcher said that they (curators) "should remain in control" of the content, Greg responded "part of it is giving the visitor control, isn't it? And letting the landscape speak.". We see increasing openness to change in the visitor experience, and curators open to handing control over to visitors. Alan's comments directly after the fieldtrip, concerning giving children a device that will occupy them for a few hours (discussed in the previous section), show a complete reversal on his originally expressed opinion that visitor experiences depend on human tour guides and that visitors should keep on a given trail. Sue shows a similar understanding. She emphasized that the system allowed children "rather than just following someone round and being told about

the history (...), to work it out for themselves, (...) rather than somebody saying OK that's what we think". She also said that the technology "has the potential to be much more flexible" than the museum guide systems she knew of and felt that the system could be "of great potential to anybody of any age or background".

The school fieldtrip, curators' first-hand experience of using the device, and seeing the children's stories, provided the curators with a vision of visitors, supported by technology, in control of their own activities. They were interested in how this could work for other visitors, particularly whether they could offer 'literacy experiences' like the school fieldtrip to adults. During the discussion, a researcher suggested employing the device to play locationbased audio clips. Greg's response clearly shows that the curators realise the value of the system's support for flexibility, and the ability of visitors to contribute content:

G: [That] isn't much different from picking up a headset and cord, is it. (...) Because the advantage of this is you're looking for the user to contribute to the experience. You don't actually have to provide a vast amount of material to, to assist the users, prompting them. Whereas for the person who wants the thorough guide, there's going to actually have to be more ground work done by that but I suppose there's an opportunity of, within that device, when Sue mentions Lutyens, to get more information on Lutyens, (...). But it's still passive isn't it.

Greg objects when we suggest a 'traditional' use of the device to trigger stories in place, and is much more impressed with the idea of letting visitors *contribute*, which can imply visitors making annotations. The issue has acquired a new meaning from the observation of children making recordings in the grounds, and from curators' engagement in these same activities. He values that the device can deliver more information on request, but feels that this is 'still passive'. When Sue in this workshop reflects on different age groups that might be interested in using the device, Greg had at first assumed that elderly visitors would prefer the "personal touch of a tour with a human guide". But then he muses: "I probably made a rash assumption that visitors above school age don't want to interact. They might not want to interact in that way, but they might be interested in recording their own observations". Sue repeatedly stressed the notion of visitors contributing to the experience and to the content: "They'd feel they're more part of it rather than just being told things, they're actually contributing to it"; "Taking an active part in it". Thus, at the end of the process, the curators have taken on board that visitor tours can be quite different to their former practice, in a number of ways that depend on understanding the technology and what can be done with content, including annotation, a concept we had struggled to convey early on.

From the start, curators emphasized interactions with visitors and how to engage them. The notion of what 'engaged' means changed fundamentally. A central resource in unfolding understandings of new kinds of user experience was activities which confronted curators with different visions of user experiences that move beyond their current practice. This started with the Ambient Wood video, which stimulated Sue's imagination regarding possible activities for the children. It continued with the realization

that the collected audio stories could be re-ordered, shifting control of content and sequence of locations to visitors; and was further developed by observing the school fieldtrip.

# DISCUSSION

In this paper we have considered the issue of how to promote user understandings of UbiComp systems to inform co-design. We have analysed what understandings are needed in the areas of content, technology and user experience, and how these unfold over time in the context of situated activities. Our research reveals some of the dynamics of this process. Here we discuss three issues: (1) how a given understanding emerges against a background of prior understandings; (2) how insights around a given concept – content, technology, user experience – can lead not just to further insights into the same concept, but also other concepts; and (3) the role of specific types of activities in promoting understandings across time.

Particular activities were associated with particular insights, for example, insights concerning the re-ordering of content happened in the context of an *in situ* demonstration of how sound clips could work; or the realization of both the static/dynamic and offset issues in the tour demonstration in Workshop 4. There appears to have been particular value in activities such as these, which recreated the experience of giving and receiving a tour. This practice of 'making the familiar strange' [2] is not new. What is interesting is that these understandings are produced not just through the current activity, but the relationship of these to previous activities. So, for example, the understanding of the static/dynamic issue occurred against a background of observing a dynamic tour, this in turn against a prior concept of tours as non-variable, revealed to us in Workshops 1 and 2 in the context of discussion, and ourselves being given tours. The understanding of the static/dynamic distinction related to the distinction between fixed and flexible tours; understanding this distinction depended on insights into other concepts, promoted through other activities, particularly the sound clip demonstration that grounded the idea that content could be varied.

The relations between activities and understandings in an 'in situ, over time' co-design relationship are complex. Here we have begun to lay out some of the dynamics. A lesson is that it is not so much particular activities that are important, but their relationship, and this implies carefully sequenced activities around key concepts. Another is the need to correctly identify, at the outset, what users already understand: we tended to overestimate this. The ultimate aim of such a process is that 'in situ, over time' techniques can potentially lead to a progressive re-imagining of the possibilities based on unfolding understandings. This process helps the stakeholders involved to own the systems they will use, and also supports the meaningful integration of these systems into their developing practice. The space of co-design of UbiComp is still in its infancy and more work remains to be done on what techniques work best.

#### CONCLUSIONS AND FUTURE WORK

The aim of the Chawton House project has been to engage its curators in the co-design of a UbiComp system, capable of delivering novel visitor experiences. We needed to engage with them to create appropriate solutions. There is a need for us as designers to provide means through which users can come to understand UbiComp in ways that can inform co-design. We wished to complement existing work on how the situated nature of UbiComp supports co-design activities, with research on the role of time, particularly how understanding emerge over time, distributed over several situated activities. Here we have shown how an 'insitu, over time' co-design process can work. Future work will include the creation of a situated authoring tool, which will allow curators to use the same device as visitors while walking the grounds to create new tours and activities. We will also conduct other events for adult visitors. These will inform our ongoing co-design relationship, particularly our understanding of curators' developing practice; and their understanding of how we can support it.

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