Connecting Physical+Temporal Events to Digital Contexts

m.c. schraefel, Ian Millard, David Millard, Gareth Hughes,
Mark Weal, Danius Michaelides, Steve Harris, Nick Gibbins
Intelligence, Multimedia, Agents Group, School of Electronics and Computer Science,
University of Southampton, Southampton, UK

ABSTRACT
In this paper we present two versions of a system we deployed to consider how to support a light-weight interaction to 'tag' a temporally and physically located event for later, digital access. In each deployment, we chose similar kinds of events, used similar interactions to tag the artifacts/information at the events, and provided similar digital representations of the artifacts/information tagged. We explore how the differences in the context of each event affected the perceived usability of the system. We present a comparison of these differences towards the development of a design heuristics for pervasive systems interested in supporting persistent access to otherwise transient information that a user has actively selected as of interest.

Author Keywords
Physical digital linking, physical interaction techniques.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Starting with Weiser's founding descriptions of ubiquitous computing environments [19], there has been a focus on the environment of deployment as a more or less static space. Similarly, Ishii's Tangilbe Bits focuses on the creative possibilities for making the intangible – like a phone message – tangible, and vice versa [6], but there is again a sense of permanence to the enabled artefacts**.** What is often missing from the consideration of pervasive spaces and the augmented artifacts that inhabit them is the notion of time, and in particular, time with respect to the transience of an atefact or event within a space.

When transience in the digital realm is considered, it is usually from the perspective of memory work: the desire to retrieve some information or reference some event that occurred in the past**.** The Forget Me Not system [10] provided iconic representations of temporal physical interactions that a user could trawl through to find the desired, associated information. More recent work in the desktop space has looked at associating significant news events with file dates in order to help retrieve related information [13]. In both cases, the system rather than the user has provided the markers for recalling information.

We are more interested in the activity that occurs before the retrieval: the ability to mark a transient event in the physical for later digital interaction. We base the notion of active tagging, rather than system-determined association of a cue with an event on complementary work in retrieving information about previous activities [3]. This study showed that re-discovery of activities was greatly improved when the person looking had themselves, months before, tagged or marked actions they saw as important events in a photo playback of their activities.

The closest analog to this desktop work in a pervasive environment is previous work in augmenting physical artifacts for digital representation/access, such as [12, 8, 11]. This work seems to rely upon two assumptions. First, that the physical artefact (or its digital analog) is the persistent focus of the interaction. Second, that the representation of the physical artefact in the digital is one-to-one. In [17] for instance, a PDA with an RFID scanner is brought within range of a physical object, such as a book, which has an embedded RFID tag. Once in range, information about the object associated with the tag is displayed on the device screen. The assumptions that the object and interaction are a person's primary focus are enforced by the system design. The interaction constraints of the system require that the user make the artefact the focus of attention: they must attend to what they do with the device in order to bring the digital information of an object into focus. The digital information about the artefact as well supports only predefined interactions/associations of that artefact, such as a link to order a copy the book.

Such research is compelling for foregrounding challenges for making physical artefacts available in digital contexts, and represents part of an interaction lexicon for engaging with digitally augmented physical artefacts. In the following paper, we describe work aimed at expanding the vocabulary of interaction for physical artefacts to consider physically based, *temporal* events, where interaction with a system to tag that object/event for later digital access is secondary to the user's primary focus.

Our motivation for investigating this interaction space is simple: there are occasions when a person may wish to gather information about a transient artefact or an event, but the cost of recording the information about the artefact or activity is potentially too high. We therefore want to understand the interaction requirements to support secondary gestures to connect physically located, temporally available information/artifacts with the id digital simulacra.

We wanted to consider how we might support lightweight interaction with physically and temporally situated artifacts for digital access. In the desktop space, an example of lightweight or *secondary* interaction may be tool selection when the primary focus is on document manipulation [9]. Similarly, multiple contexts of association may be supported by any number of focus + context systems [15], allowing the user to navigate from a particular source to multiple contexts associated with that source. We wish to bring such interactive options into the physical/temporal realm of digital interaction. We are particularly interested in the problems of translating to the digital artifacts that only exist in a location for a short period – for an afternoon or a few days – where the opportunity to return later to make a note is not feasible.

In this paper, we present two systems we deployed to explore the two attributes of a physically temporal to digital system: (1) the affordances necessary for a light-weight interaction to "tag" an artefact in the physical for later access in the digital, and (2) the assoicatied contextual information in the digital that would need to be provided to make accessing that information again in the future viable or desireable. In the first system we focused on a lightweight interaction gesture simply to mark a physical artefact for later digital retrieval. We also situated information about the event context to support the representation of that artefact as part of a context. In the second system, we supported both marking and annotating the artefact for later retrieval. In this trial, the annotations acted as alternate contexts for the artefact.

In the following sections, we present first related work, then a description of the systems we developed and the observations we conducted to understand focus+context as applied to the selection of physical/temporal artifacts and their digital representations. We follow this discussion with an analysis of our findings. We close with the conclusions we have drawn from the work, and what are next steps will be.

RELATED WORK

We are looking at two concepts in particular. First, we are looking at affordances for the design of lightweight, secondary gestures to select physical artifacts for later access in digital form. Second, we are looking at how the affordances of both the gesture itself and the digital representation of the artefact may assist later access to either that information itself, or other information associated with that artefact. Therefore, we need to consider previous related work in augmented physical artifacts, retrieval of events, and incidental interaction.

Augmenting and Representing Physical Artefacts

There is a substantial body of work for interacting with physical events or artefacts in digital systems. One of the earliest systems was Parc Cambridge's Active Badges [18], first deployed to support locational awareness for Parc employees, thus creating a digital representation of a person's tracks through an environment. The Forget Me Not [10] system built on this, integrating locational tracking with other system tracking such as phones and computers, along with scheduled events in order to help provide contextual information for discovery. There are also a number of systems which have been developed, from Phicons [11] to Paper-based PDAs [4] In [17] Electronic Tags were used to allow digital representations of an artefact to be triggered by proximity to their analog counterpart.

More recently Equator's City [2] and Ambient Wood [13] projects have considered real time scenarios where digital information augments physical interaction. In these cases, proximity to an artefact triggers associated information to become available to the participants. In each case, the participants' physical context determines the available digitally enhanced information. In particular, Ambient Wood's use of probing devices is the closest analog to the system we wish to investigate for tagging and revisiting transient events. Ambient Wood lets children probe the wood with various devices. The record of the thing probed, what it was and, where appropriate, its state are recorded as part of a group gestalt` of a team's rather than an individual's visit in the wood. Post wood outing, students revisit their exploration by considering with their teacher what they had probed. In our case, we were interested in supporting individual tagging and revisiting of information.

THE VISIT SYSTEMS

In order to investigate how we might enable tagging of a physical/temporal event for later recall, we deployed our system for two distinct events. The first event was to support prospective undergraduate students. As part of their tour of Computer Science, the students spent time at a poster demonstration session in order to get a sense of the research activities in the department. We gave them an iButton with which they could "tag" demonstrations of interest to them. This action added the digital profiles of the posters they had tagged into a single collection, similar to collection making in [16]. Later students could visit a web site that presented the collection of tagged demonstrations for them with information not only about the projects they'd tagged, but about the courses they could take if they wanted to build what they'd seen. Links were provided to more complete course syllabus information.

At the second event, we also deployed the tagging mechanism around posters and demonstrations, this time at a conference. Though the physical and post visit interactions were largely the same – participants could tag posters and demonstrations, and again be presented with the collected information about the posters they had tagged – the event context was quite different. At the Preview Day event, students (and their parents) had more or less the same agenda in going to the visit: to make a decision about both an area of study and a university; similarly the university had a consistent agenda: help students make this university the one for them.

At a conference, the agenda is not so tightly focused. Similarly, the differences among the age, interest and experience of participants is significantly more distributed. Also, no one can make a participant go to a given session at a conference. This was not the case with the Preview Day visit. So while the deployment of the system at the conference was similar to the University, and while it was also deployed in the context of a well-defined, temporal event, the context for the interaction with the system was far more amorphous. We therefore sought to facilitate users creating their own context for the event by providing a mechanism to create annotations about the posters, either for themselves, the visitors in the hall, or the authors of the posters/demonstrations.

We describe both deployments below, and our observations of the systems in use. We conclude with a synthesis of these observations towards a preliminary understanding of the issues for supporting tagging of physical/temporal events

The University Visit System

Our belief was that the 'tagging' system could provide a connection between the demonstrations of research activities present on the day and information provided on the web that connected those projects to appropriate undergraduate course information. In addition, it was hoped that the "gee-whiz" factor would make the day more memorable for them.

The designed system, "Forget About It", allowed students to 'tag' posters and demonstrations for later retrieval. Subsequently, they could visit a web site that presented information about the demonstrations they had and had not seen. Further information relating to these demonstrations was available (project information, URLs) and importantly a list of undergraduate courses they might like to take based on the content of the demonstration. The demonstration event provided a context for students to learn about the undergraduate courses.

Setup

Central to the tagging process were the iButtons [1].

IButtons are key-fob sized devices (Figure 1) which carry a unique identifier. This identifier is read each time the button is clicked into an iButton dock**.** We built a system which let us associate information about the participant with the iButton. In this case, we associated name, school and email address with the id. Also, the system allowed us to assign an identifier to each docking point. Therefore, we could associate a specific iButton dock both with the name of the poster with which it was associated, and the location in the room of that poster. Thus, when a student docked their button by a poster, the system recorded who docked, the time they docked, and the location and name of the location where they docked.

Figure 1. An iButton and fob. ID number outlined, right

iButtons are only one of several possible technologies that could be used for tagging artifacts for future access. Smart cards, RFID tags, barcodes are all possible substitutes. We used iButtons for cost: the buttons themselves are cheap at less than a dollar US for the button and a dollar for the fob. The readers as well are affordable enough to place at many stations in a room, where as the price of that many barcode scanners, rfid tag stations or smart card readers would have been prohibitive for testing in a real deployment.

Training

Students arrived in groups of 20-30 people at a time. They were given an iButton on arrival. They were given a handout briefly explaining what the iButton was for, and how they could access their custom page before they went into the event. We asked students to register their iButtons before they went into the demonstration room. Registration meant docking their iButtons at a computer terminal, where they saw a screen inviting them to dock their iButton and register. A successful dock brought up the registration page where they could enter any of the requested information. We explained that this was a convenience not a requirement: they could log into their custom web page either by entering the email address they registered or by using their iButton's id number. All students chose to register.

We had two registration terminals set up. Registration was supervised so that if anyone had a hard time docking, we were there to help them. This gave them experience with docking their iButtons to register an event. Once registered, students proceeded into the event.

Visit

To the front of the room where students entered, we projected the list of docking events on a screen in one window. In another, we showed on a map of the room where docking action was taking place, shown in Figure 2. This way, students could see the list of docking events, as

well as see on a map of the room where other students were registering their interest in a poster.

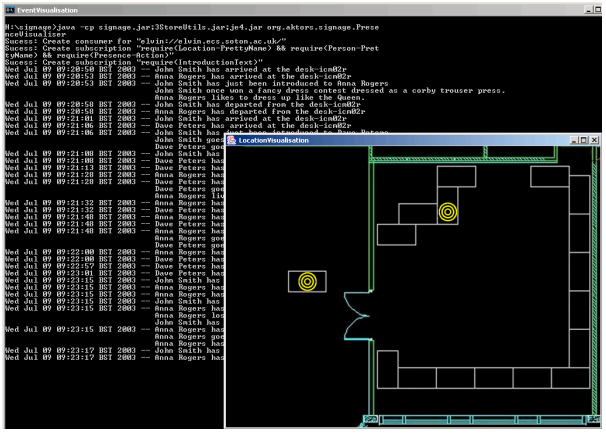

Figure 2. In-room projection of list of people's dock-events (background) and view of current dockings (foreground).

iButton docks were placed alongside the demonstration stations. Students could dock their iButtons at any time. The feedback cue they had of a successful event was seeing the event on the screen.

Students were told they could keep their ibuttons as a persistent reminder of the event and to facilitate the later retrieval of the personalized web page. After the event, we also sent a follow up email with the web page location to remind them where they could visit the site and what they would find there.

Post visit experience

On visiting the Visit web site, students were presented with a web page that asked them to log into the site with either the email address they registered at the event, or the id number on their iButton. Based on this information, a web page was generated dynamically representing the posters they had visited, see Figure 3.

The entry for each poster included an image of the system they visited, its name, a brief description of it, and a link to the site associated with it. We also provided links to the courses they would take in the program if the wanted to build the system they visited. Clicking on the name of one of the listed courses opened up a brief description of the course, and provided a link directly to the detailed course syllabus.

After the presentation of posters the students had selected, the students saw "For your information, these are the posters you didn't tag." Students could of course ignore these if they wished, but we wanted to provide them with as much of the context of their visit as possible.

Observations

We had two visit sessions of approximately 45 minutes each and 20 minutes apart. We had been told to anticipate at most 20 visitors per session; instead we had twice that number. Consequently, the room was generally quite crowded, averaging 50 people during either of the two visit sessions during the morning.

For the most part, either pairs milled around posters, or groups of 5-10 students gathered around various presenters. We noticed no specific pattern to docking. Students tagged/docked before, during and after such gatherings. We recorded over 1000 docking events in the space of two, with 83 students to 12 posters/demonstrations.

The students reacted to the iButtons with enthusiasm. Before they entered the room, as the purpose of the device was explained to them in terms of how they could select information for later, and what they'd be able to get when they went to the site afterwards, we heard comments like "good idea" and "that's actually useful". Over the two week period following the event, over 35% of the students accessed the visit site more than once.

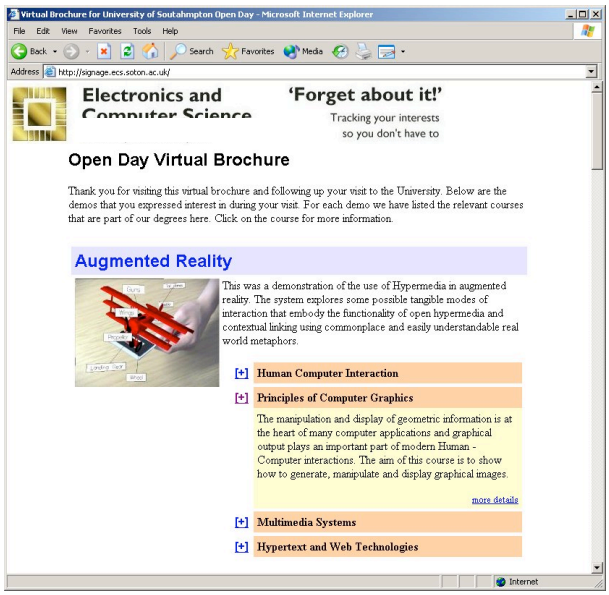

Figure 3. The Post Visit personalised page.

Discussion

The goal of the visit event was to impress students with the work in Computer Science at the university; the associated goal of the Visit site was to make it easy for students to return to the things they found interesting, but also to associate those things with the context of becoming students in this department at this university. Therefore, we connected their actively selected interests with the appropriate parts of the curriculum that supported that interest. Rather than thumbing through a rather dry university calendar, they had a reason to see how discrete math might factor into something of interest to them.

As this was a preliminary exploration and we didn't wish to prejudice the student's view of applying to Southampton we didn't follow up the event by email. The positive response we heard during the event, however, combined with the number of dockings recorded during the visit sessions, and the percentage of repeat visits to the web site following the

event suggests that we found a mechanism that provided a meaningful way to connect a physical, temporal event with a digital representation both of it, and of the context of the event itself. The students actively selected certain posters over others for further exploration. A strong percentage of these students (35%) found the experience interesting enough to want to visit the website.

Conference Visit System: Tagging with Annotation

The conference Visit System utilized the same set up as the University Visit system, but was extended to cover two rooms hosting the conference poster sessions. There were 8 posters and 6 demonstrations within the two rooms.

The iButtons had two functions in this deployment the iButton docks were supplemented with an annotation system, allowing users to not only register their interest in a particular exhibit, but also to leave associated comments as they perused. The system consisted of a computer terminal placed next to each poster/demo, adjacent to an iButton dock. The annotation application, running on each terminal, had two main parts; a display of annotations which have been left by previous visitors, and input controls to facilitate the addition of annotations. Each conference delegate was given an iButton with their conference pack and instruction sheet. The use of the system was explained by the conference chair at the opening session and on further occasions.

To leave an annotation the user first docked their iButton, identifying the user to the terminal, and enabling the submission part of the screen. Input fields were provided for the title and body of the annotation, along with the facility to flag the annotation as being one of three types – 'public', 'author-only', and 'private'. Public annotations are viewable by all, and displayed on the screen at all times. Author-only annotations are only viewable by the author of the annotation and the author(s) of the poster/demo, when either party is docked-in to the terminal. Private annotations are only viewable by the author of that annotation, providing a 'note to self' facility. After the annotation details have been entered, a submit button commits those details to the system, after which the user's iButton can be removed.

Running in parallel with the annotation terminals, and subsequently after the conference, the Visit System website provided each delegate with a customized page relating to their visit to the poster/demo sessions. Those exhibits for which the user had expressed an interest (by tagging them at the conference) were presented, along with all of the annotations which were visible to that user. There was also the facility to leave further annotations relating to any of the exhibits.

The conference schedule was such that poster sessions competed with plenary sessions. Also all refreshment and lunch periods were held in a marquee hosting the commercial exhibitors, some distance from the poster rooms. The subsequent low numbers of visitors to the poster rooms and hence low usage of the system prompted the moving of refreshments to a room adjacent to the posters for the final day.

Participation and Training

Due to the number of pre-registered participants at the conference (278), we associated buttons with participant name and email address in advance. Delegates received an iButton in their bag, along with an instruction sheet on both how and where they could use the system if they wished to participate in a study of the system. If they did not wish to participate in the study, they were asked not to use the system and simply return the iButton. This information was also announced several times during the conference. Beside each annotation terminal at each of the posters, there was also a color-printed instruction sheet in 12 point type. No other training was provided for the system. We had certain assumptions about the ease-of-use of the system, and this deployment would let us see how clearly the usability was communicated.

Observations

Over the course of the two and a half day event, 92 participants used the system, creating 90 annotations. Half of these users were tagging interest; half were leaving annotations. Of those who left annotations, 50% were left for the author, 40% were public and the remainder were private annotations. We sent out a questionnaire to participants following the conference focusing on their experience of the system. The questionnaire asked them both to rate various attributes and to comment on their ratings. 36 participants responded. Some also sent us separate emails. We had a range of responses from the questionnaire. Based on this feedback, two weeks later, we sent out another email with more specific questions, asking participants to reflect upon their experience with questions like, 'When you found the iButton and explanation sheet in your registration pack', 'What did you expect the system would let you do?', 'Did you visit the web site?', 'Did what was on the web site meet your expectations?' From these questions, we hoped to get a clearer sense of the usefulness and usability of the system. We review the results of the first and second questionnaires below.

iButton Usability

There was a strong sentiment about the ease of use of the iButtons. While 10 of the 36 questionnaire respondents either agreed or strongly agreed that they were usable, 14 disagreed/strongly disagreed. When asked how useable the iButtons were for docking, 14 people rated their usability in the low range, while only 2 rated them in the highly usable range. Comments about the usability of the iButtons suggested reasons for the strong divergence of views. Several people commented on the lack of feedback on the docking stations themselves, even through the associated video monitors registered the docking action, and it was

commented by some that the stations themselves were small and difficult to locate.

Although several people praised the affordances and ergonomics of the iButton fobs, one person resented having to carry a physical item and make an explicit action and thought that a wireless solution would be better. Several people also complained that the unique id, engraved on the button itself, was too difficult to read. One said that the similarity of the devices also made distinguishing between multiple iButtons difficult.

Understanding the experience

Although a few comments pointed at difficulties that visitors had with the physical and software interfaces of the system, most confusion arose from a more fundamental misunderstanding of the purpose and functionality of the system within the context of the conference. This misunderstanding seemed to manifest itself in two separate ways. First, visitors did not always understand the purpose of the tagging action and did not appreciate the effect that it would have on the post-visit experience. Second, they became confused between the utility of tagging and the facility of making annotations, for example, several people thought the iButtons merely functioned as a key that allowed them to access the annotation system, rather than as a device to mark and collect information of interest.

A few people also commented that the number of items that could be marked was too small in scope and that the system would have been more useful if there had been a greater number of posters and demos to tag. One had the opposite view: seeing the system as a memory prosthetic.

Accessibility Issues

Accessibility was a concern to some of the visitors who drew attention to both the limitations of the software interfaces and the iButtons themselves to visually impaired visitors, in particular that the size of the text on both the iButtons and the video monitors was too small.

The Organization of the Event

The organization of the posters and demos session had a serious impact on the way in which the visit system was experienced. Instructions were given in the opening session and printed instructions were also provided, but many people missed the opening morning and others lost or overlooked the instructions. A lack of on-screen instructions (those given referred to the physical interface, not the conceptual use of the system) confounded the problem.

The refreshment periods between the main conference tracks were held away from the demo and posters area. Similarly, poster sessions were scheduled concurrent with papers sessions. For these reason many delegates spent very little time in the posters area.

It was also commented that there was no terminal in the room for participants to see the visit page while at the event if they did not have their own laptop. A kiosk was suggested as a way of allowing visitors to see what the results of their tagging actions would be.

Perception of System

There was no strong consensus on what the experience of the system would be. While the majority of respondents to our second questionnaire understood that they would be able to tag a poster for later access to the information, one person thought that they would discover a link only to the poster's web site, another thought they would have access to a discussion forum. Some thought the iButton was strictly to enable the annotation system rather than also tag a poster for later reference. Interestingly, of participants who only tagged posters without leaving any annotations, few went back to the web site to see what they had tagged.

Discussion

Despite issues around location and scheduling of poster events that reduced the number of users over the three day period, 91 out of 278 people tried the system at least once. Similarly, we had a good return rate on the web questionnaire and email questionnaire, sufficient to gain insight into the strengths and weaknesses of the deployment. From the logs and the participant responses, we can see that there was a mix of views as to what the system was for: half the participants who used the conference visit system saw it only as a bulletin-board style service where they could leave notes for the poster presenters. Indeed, the presenters themselves used the system to leave notes for the public, like "I'll be back at 15:30." It is likely that, by having one interaction to both tag and initiate an annotation, we conflated the conceptual use of the system. The concept of tagging in order to return to information of interest did not seem to percolate past the concept of tagging to leave an annotation. The dual functions needed to be more clearly separated.

Few people who simply tagged posters without leaving annotations actually returned to the web site to revisit what had been tagged, despite being sent an email as well with a direct link to their customized web page. Plainly the value of the interaction was not high enough to sustain use of the information. There are numerous possible reasons for this: the poster sessions themselves were, unfortunately, poorly attended, underlining their lower status in a conference environment. Being set up both away from the main paper session locations and the coffee areas, as well as being scheduled to compete with paper tracks may only have helped that impression. As such, the motivation for use was low. Similarly, watching others in a group use a system increases willingness to try something novel; we did not achieve a critical mass of people trying out the system and thus encouraging others to try the activity, too. Indeed, one participant said that he'd gone to use his iButton and another participant said "oh yes I want to try that too, that looked interesting – I've just forgotten mine [iButton] today."

The lack of hands on training with the system, as we had with the University Day at the registration terminal also became an unanticipated barrier to use. We were too optimistic about transparency of the system, and similarly not evangelical enough on site about demonstrating use. This, combined with what our mix of participants told us about reading difficulties, and docking issues, meant that take up was poor.

Analysis to Date

The concept of being able to do what we had planned to do – tag physical events for later information retrieval – was met positively. The desire for the imagined functionality is there. It is worthwhile reflecting on the differences between the University Visit system and the Conference Visit system, since the former could be judged a success and the latter, not, beyond the value of analyzing the data for what went wrong.

The University Visit Day had a clearly defined context both for the university running the event and for the students participating in it. The university wanted to encourage students to be undergraduates there, and the students wanted to find out if this is indeed where they would like to be undergraduates. As such, that context seemed to support the value both of tagging posters of interest and of returning to the visit site afterwards to pursue the associated information about posters as well as associated courses.

The Conference Poster Sessions had a less clearly defined context. Posters frequently have an ambiguous value at conferences. They are often the second string event next to the papers tracks. Most conferences schedule a time just for a poster sessions, or collocate posters with coffee breaks. Few people comb through poster proceedings to see which poster they wish to visit, the way they do with papers in paper sessions. One of our goals in setting up our system at the posters was to provide an extra incentive to visit them: check them out, and test a novel interaction system. It turns out that we may have been overly optimistic in thinking that, at an event where there is already such competition for attention, and where interaction systems of all kinds were on display and being discussed as the raison d'etre of the conference, that our system would even register in the minds of delegates, especially without hands on encouragement and direction. This is especially perhaps because we were introducing a new interaction and a new concept. Some people who were familiar with iButtons as login authorization devices for things like cash registers or access panels, did not make the connection that we were repurposing the device as something else. Similarly, the concept of tagging a posters into a collection of information for later access is new thing: it is not an improvement on a previous design for scrolling or a different way of managing mail; it represents a new concept. All the more reason, perhaps, for hands-on training.

That said, that the majority of the participants indicated that the concept of tagging was valuable suggests that it is worth pursuing, both to refine the interaction and the associated affordances.

Fundamentally we have learned that the success of tagging physical/temporal events for later digital has little to do with the number of artifacts available for tagging: compare the 1000 tag events by 85 students in two hours for 12 posters with the 182 events by 91 people over three days. Rather, tagging seems to be strongly associated with the value of the artefact, and possibly the promised associated information, to the person doing the tagging. In that case, context has a strong contributing effect on the perceived value of tagging, cost of interaction and desire for later retrieval.

Initially, we were surprised that the posters at the conference did not trigger a higher value for tagging, since we had seen both University and Conference poster events as very similar. After looking at the results from the events, and going through the comparison between differences in context for participant and organization, training, user profiles and deployment, the strong differences between events become clear.

The challenge in a ubiquitous context then becomes at least in part how to support tagging in environments where motivational contexts for capturing transient, event-based information are potentially not highly constructed .

FUTURE WORK

The two observations we performed of the Visit Systems have foregrounded some possible factors to improve assisting people with tagging physically, temporally located artifacts/information for later digital access. One factor may be the motivation itself. We believe that the use of a physical icon like the iButton helped to encourage participants both to identify information of interest and to return to the selections that they themselves had made. We do not know, quantifiably, whether this active gesture significantly improved selection or focus of interest for later retrieval. For instance, we could potentially have told the visit group to the University that we would email them the link to a web page of all the posters and related courses. This may or may not have resulted in a similar return rate in itself to the web site. Thus, active selection may or may not have had an impact on the meanfulness of the data to which the participants returned.

Similarly, some participants mentioned that there was not enough feedback with the iButton as to whether or not it was docked. We wish to investigate the feedback for tagging further: we wish to use situated displays in order to see if showing users the digital information they are capturing, and showing them the collection of information they are building, makes the system more "sticky" more usable for them, as compared to more simple visual or audio feedback like a light going on when a tag has been made

Both the above investigations will help us better understand the factors (and costs) involved in supporting the capture of transient, physically located events for later digital access.

CONCLUSION

In this paper we proposed an extension of the pervasive computing design space to include consideration of physically located but temporarily available artifacts/information. To this end, we introduced interaction support for actively selecting such physically located, but transient artifacts/information for later digital access. We compared two similar deployments of a system that supported lightweight tagging for later digital access of information associated with posters at short-term events. We showed that, while similar, in each case, the context motivating participation in the event where tagging was available seemed to play a strong role in the degree to which the system was used, and perceived to be useable and useful. From this work, it seems that the relation of context as motivation will prove to be an important heuristic for deploying pervasive systems to support temporal events.

ACKNOWLEDGMENTS

REFERENCES

1. iButtons (microchips housed in 16mm metal canisters). http://www.ibutton.com/.
2. Brown, B., MacColl, I., Chalmers, M., Galani, A., Randell, C., and Steed, A. Lessons from the lighthouse: Collaboration in a shared mixed reality system. In *CHI* (2003), pp. 577-584.
3. Czerwinksi, M., Horvitz, E. An Investigation of Memory for Daily Computing Events. *Proceedings of HCI 2002: Sixteenth British HCI Group Annual Conference, London, England, September 2002*.
4. DeVaul, R. W., Clarkson, B., and Pentland, A. S. The memory glasses: Towards a wearable, context aware, situation-appropriate reminder system., 2000. In CHI 2000 Workshop on Situated Interaction in Ubiquitous Computing.
5. Heiner, J. M., Hudson, S. E., and Tanaka, K. Linking and messaging from real paper in the Paper PDA. In *ACM Symposium on User Interface Software and Technology* (1999), ACM Press, pp. 179-186.
6. Ishii, H., and Ullmer, B. Tangible bits: Towards seamless interfaces between people, bits and atoms. In *CHI* (1997), pp. 234-241.
7. Ito, N., Fujita, N., Shimazu, H., Nakajima, N., and Yamada, K. Transworld: paper world as avatar of electronic world. In *CHI* (1999), pp. 206-207. Extended Abstract.
8. Johnson, W., Rao, R., Hellinek, H., Klotz, L., and Card, S. Bridging the paper and electronic worlds: Paper as a user interface. In *INTERCHI '93* (April 1993).
9. Kurtenbacht, G., and Buxton, W. User Learning and Performance with Marking Menus. In *CHI* (1994), pp. 258-264.
10. Lamming, M., and Flynn, M. Forget-me-not: intimate computing in support of human memory. In *Proceedings FRIEND21 Symposium on Next Generation Human Interfaces* (1994). Also available as RXRC TR 94-103, 61 Regent St., Cambridge, UK.
11. Moore, D. J., Want, R., Harrison, B. L., Gujar, A., and Fishkin, K. P. Implementing phicons: Combining computer vision with infrared technology for interactive physical icons. In *ACM Symposium on User Interface Software and Technology* (1999), ACM Press, pp. 67-68.
12. Moran, T. P., Saund, E., Melle, W. V., Gujar, A. U., Fishkin, K. P., and Harrison, B. L. Design and technology for collaborage: collaborative collages of information on physical walls. In *ACM Symposium on User Interface Software and Technology* (1999), 12, ACM Press, pp. 197-206.
13. Ringel, M., Cutrell, E., Dumais, S., and Horvitz, E. Milestones in Time: Value of Landmarks in Retrieving Information from Personal Stores. Proc. of Interact 2003, pp. 184-191.
14. Scaife, M., and Rogers, Y. Traversing between the digital and the physical: what does it mean? In *Workshop Proc on Moving between the physical and the digital, I3 Spring days, Porto, Portugal* (Apr. 2001), pp. 7-9.
15. Schaffer, D., Zuo, Z., Greenberg, S., Bartram, L., Dill, J., Dubs, S., and Roseman, M. Navigating hierarchically clustered networks through fisheye and full-zoom methods. *ACM Transactions on Computer-Human Interaction 3*, 2 (1996), 162-188.
16. schraefel, m., Zhu, Y., Modjeska, D., Wigdor, D., and Zhao, S. Hunter Gatherer: Interaction Support for the Creation and Management of within-Web-Page Collections. In *Eleventh International Conference on World Wide Web* (2002), pp. 172-181.
17. Want, R., Fishkin, K. P., Gujar, A., and Harrison, B. L. Bridging physical and virtual worlds with electronic tags. In *CHI* (1999), pp. 370-377.
18. Want, R., Hopper, A., ao, V. F., and Gibbons, J. The active badge location system. *ACM Transactions on Information Systems (TOIS) 10*, 1 (1992), 91-102.
19. Weiser, M. Some Computer Science Issues in Ubiquitous Computing. *CACM* (July 1993), 74-84.