Context-Aware Computing: A Test Case

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Abstract. Through an iterative design approach, we have proposed and evaluated ways of incorporating user-created information into context-aware systems. We implemented and tested a location-sensitive college campus tour guide called Campus Aware that allows users to annotate physical spaces with text notes. The goal was to provide visitors to the campus with a sense of the activities going on in the environment. Our evaluation of Campus Aware revealed that users provided unique content that was interesting and useful to others. They also served as moderators posting corrections to inaccurate notes and answering questions posed by other users. We discovered that our system easily became a distraction and was not able to detect location precisely enough to prevent user confusion. Our findings suggest new ways to make context-aware systems easier for users to comprehend and enjoy.

1 Introduction

Every year thousands of prospective students descend on the Cornell University campus as part of their quest to decide which school to attend for the next four years. To help them get a sense of the campus, current undergraduates are trained to show groups of visitors around. These ambassadors talk about the history of the campus and answer questions about what it's really like to go to school at Cornell. Prospective students often sit in on classes, eat in the school cafeterias, stay in dorm housing, talk to faculty members, meet with administrators, and ask a lot of questions.

At the same time, current students go about their business, doing homework, taking exams, participating in extracurricular activities, doing more homework and attending classes or parties. Some students take time to host and entertain these visitors. Others help out by simply pointing them in the right direction when they get lost on the sprawling 745 acre campus. Many other students do not interact with these prospective students at all.

How good a sense of college life do prospective students get during their brief visit? Can we improve this experience by finding new ways to help current students share their knowledge and experiences with prospective students? As part of our

research in context-aware computing we designed a location-sensitive tour guide called Campus Aware. This tour guide allows members of the campus community to annotate physical space with knowledge and opinions. Prospective students can also annotate space with questions and thoughts as well as read comments made by those who are knowledgeable about the campus. The purpose of this tour guide was to effectively cover the Cornell campus with the buzz of relevant digital conversations reflecting the perspectives of the people who inhabit the space and the activities that occur there.

Beginning in section 2 of this paper we will detail the ideas and theories that we were exploring with the design of this system. Our research primarily focused on context-aware computing and methods for incorporating user behavior and knowledge into this type of system. Section 3 is a description of the Campus Aware system and the iterative design process we followed. In the final portion of this paper (section 4) we will describe our evaluation of the system with a focus on usability.

2 Theoretical Basis of Research and Related Work

2.1 People as Context and Context-Interpreters

Computing systems that are context-aware have been discussed, proposed, prototyped, and implemented ever since the Olivetti Active Badge project [21]. Along the way a number of location-aware guides have been designed for city tours [1, 5] and frequently for museums [3, 13, 22]. A series of similar systems usually grouped under the term augmented reality rely on elaborate head mounted and wearable displays [10, 18, 20]. A few researchers have even begun exploring the idea of incorporating content created by users into these location-aware guidance systems [9, 17, 20].

Proponents of context-aware computing suggest that a system that can take into account the context of use can cater more specifically to its users. Location, time, identity, and activity have been proposed as the primary elements of context [7]. The ability to detect context seems especially relevant to mobile and ubiquitous computing systems which may be used in a variety of different locations, by different users, and/or for different purposes. We believe that user behavior is itself a form of context. Where and when people congregate, how many people are present and for how long are all indications of events going on in the environment. Certain aspects of context such as time and location are easily detected, however others, such as activity are much more difficult for a computing system to ascertain. People, on the other hand, are good at detecting, predicting, and understanding activity and motivation. They take a great deal of context into account when they communicate. We are interested in making use of this ability by allowing users to play a role in interpreting context, rather than leaving that job entirely to the computer. By forming a partnership between the context-detecting computer and the context-detecting user we believe a more sophisticated and useful system will result.

2.2 Social Navigation, Social Maps, and Annotating Space

A context-aware tool with a social component could take on many forms. Assume the system in development is the archetypal location-aware tour guide. We have been developing the idea of "social maps," as a way to leverage knowledge and behavior from other users. These maps would overlay aggregated user data onto a geographical map of the area. This user data could be locations visited, how much time users spent at each location, or it could be ratings the user submitted voting on how beautiful or interesting the site is. Later users would be able to use the map to physically navigate towards (or away) from sites based on their popularity. Another method to gather input from users would allow them to annotate spaces with text notes. This method requires more effort from users, but has the most potential for creating interesting content.

The idea of collectively gathering information from users and using it to influence and guide other users was inspired by research in social navigation. Most researchers studying social navigation use these ideas to open up networked information spaces (often web resources) to dynamic user-created content. However, it has been pointed out that we can witness social navigation both in the "real " world and in the "virtual" worlds of information spaces [14]. In the physical world people observe the behavior of others all the time to determine where to go or what to do. You see this every time people follow a crowd to see what's going on, follow a hiking trail, or even follow someone's gaze to see what they are looking at. However, without the presence of other people or the traces they leave behind users cannot benefit from what others have done. Our concept is to create an information space of user behavior and comments layered on top of physical space to make these traces visible for an extended period of time. A system that includes social maps and annotation of space with notes allows users to leave traces in a physical space that would otherwise have no record of who was present and what went on before.

Fig. 1. a social map, each dot represents a user visit to the specified location. Dots are assigned a color to indicate how well-liked the location. Users register their opinion by submitting a numeric rating while at the location.

3 Description of Campus Aware and Our Iterative Design Approach

Our research into this idea of incorporating user behavior and knowledge into a context-aware system began in 2000. We started exploring this space with a system called E-Graffiti that ran on laptops connected to a wireless LAN [4]. It allowed users to create text messages and attach those messages to a location where anyone could read them. A number of usability problems emerged in the evaluation phase of the project. Users were "misusing" the system, transforming it into a synchronous chatting system and ignoring all of the context-awareness functionality. Many of the problems with system adoption related to the system's dependence on user input. Our goal for the next iteration of the design was to make the context-awareness functionality more relevant and find ways to motivate users to create content.

The second iteration of this project is a system called Campus Aware which is a college campus tour guide that detects the user's location and provides relevant information. When we designed Campus Aware we tried to make some changes to resolve some of the issues users had with E-graffiti. First, we moved to a different form factor (from laptops to Palm V's) that would allow more mobility and thus greater and more frequent changes in context. We also switched to GPS for more accurate location-detection. We designed the system to be used for a specific activity where the connection between context (specifically location) and system content was highly relevant: a campus tour. We purposefully kept the implementation of our

context-aware system as simple as possible in order to focus more energy on the evaluation of the system. Our primary research goal was to make a simple and reliable system that would allow us to test and uncover some of the usability problems unique to the area of context-aware computing in combination with this social component. We used Palm Pilots because they were readily available to us, as was a GPS receiver that attached directly to the Palm Pilot. We left out some obvious features such as a campus map for the sake of simplicity and because of the time involved in programming and testing to make sure the system was reliable enough for users.

We provided several ways for users to create content for the system. The first was through text annotation of physical locations. Anyone who uses the tour guide is able to annotate a physical location with text they write on the Palm Pilot. However, we were concerned that user input into the system would be difficult while mobile, so we provided two additional ways to create and contribute information. We implemented a simple voting form that asks users to vote on their current location. This requires much less effort on the part of users than writing a full text note on a Palm Pilot. We also created a web-based interface for adding notes to the system with the idea that undergraduates, professors, administrators, and other members of the community could easily contribute notes from a desktop computer. The research team seeded the system with primarily factual notes to give the initial users something to view during their evaluation of the system.

Fig. 2. A list of notes related to the current location. Each note has been written by a user.

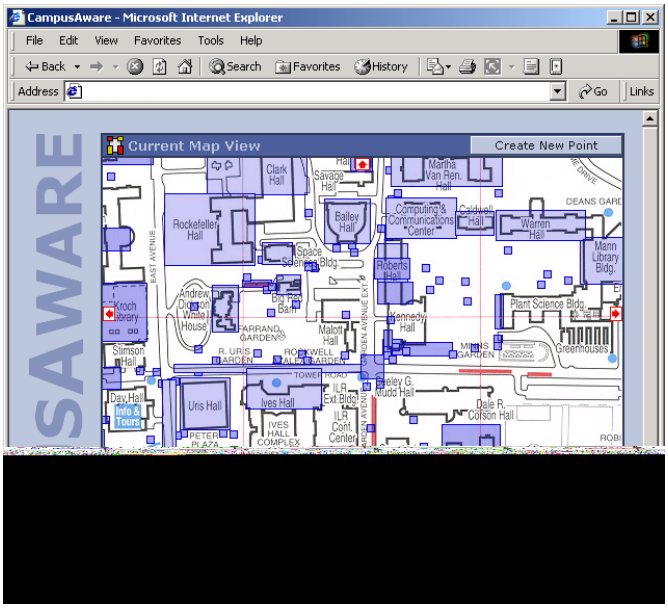

Fig. 3. This is a map of campus with blue rectangles indicating where notes have been posted. This interface is accessible from a web browser and can be used to read or add notes to any campus location. We created it for students, faculty, and staff who may want to contribute expert knowledge to the system without having to use a handheld. It can be viewed at http://testing.hci.cornell.edu/CampusAware/

4 User Evaluation of Campus Aware

Our evaluation of Campus Aware is divided into three areas in this paper, all focusing on usability issues. The first area is about general ubiquitous computing concerns specifically focusing on the balance of attention between the device and the physical environment. The second area is about the user annotation feature of the system. The third area is about the context-awareness functionality of Campus Aware. A number of interesting results point to the unique concerns related to designing context-aware systems that are easy for user to comprehend, use, and enjoy.

The Cornell campus was an ideal test bed for this technology because of its vast size and because it is so self-contained. This allowed us to recruit testers from both the general student population who were well acquainted with the environment and visitors who were not. We evaluated Campus Aware using a combination of surveys and usage data. Thirty-two Cornell undergraduate students took campus tours individually using the Campus Aware system during the fall of 2001. Each tester signed up to test the system for one hour and was given an instructional sheet about how to use the system. However, users were given no specific directions as to what they should do with the system during the test. We decided to evaluate the system initially with undergraduates as a way to seed the system with user comments. We were also interested to see the kind of feedback we would get from users who were experts in navigating the environment. In addition, evaluation of the system with prospective students who are novices to the environment is currently underway.

4.1 Usability and Ubiquitous Computing

The concept of ubiquitous computing takes a giant step away from a user sitting at a desktop computer. And similarly we can expect the usability issues to be very different as well. Some proponents of ubiquitous computing suggest that usability problems will be solved merely because these systems are integrated into the physical environments we interact with effortlessly every day. We argue that usability problems with computing technology do not disappear simply by integrating that technology into the physical world. Don Norman's book The Design of Everyday Things showed that even something as innocuous as a doorknob can pose real problems to people [15].

One major usability concern relates to the fact that ubiquitous computing systems are often designed to be supporting players in what is essentially a user experience based on interaction with the physical world. That experience could be a guided tour [1, 5, 23], classroom lecture [2, 11], driving a car, answering the phone [21], or any number of other activities. Once you embed computing technology into the environment, the individual can no longer attend exclusively to a computer interface whether this interface is something tangible (like a knob, toy or telephone) or a more traditional computing device (like a computer screen or keyboard). This leads to an important question, when should the computing system blend into the background and when should it somehow grab the users attention? This question is particularly important in certain areas of ubiquitous computing research; for example it is a crucial safety issue in embedded automotive computing systems. Our group has previously

done research on distraction among students using wirelessly networked laptops in a classroom [11]. We addressed the issue of distraction again in our evaluation of Campus Aware.

4.1.1 Distraction

We envisioned Campus Aware as an unobtrusive guide to the physical environment providing information to the user only when it was relevant and novel. Our philosophy was that the primary experience was viewing and experiencing the physical campus and that our system should play only a supporting role.

Researchers at Xerox Parc have pointed out that in a museum setting "at least three entities demand the visitor's attention…1) an information source…2) their companions; and 3) the location itself…guidebooks and tours have the potential to help or hinder visitors as they strive for optimal attentional balance," [22]. We implemented several features in Campus Aware to aid this goal of attentional balance. First, the interface was designed with an audio alert to notify the user when a relevant note became available to read. Our concept was that a user would put the device in their pocket and use it like a beeper, only viewing the interface when there was something new to read. We also built in a second feature which "remembered" the notes that had already been viewed and silenced the audio alert when an old note reappeared.

Despite the features we built in to prevent distraction we observed that users did not use the device like a beeper during their evaluation of the system. Instead they held the Palm Pilot in their hands staring at the interface until something appeared. They were essentially oblivious to the physical environment surrounding them except when they looked up to notice something referred to in a note they read.

A few users did seem to notice this distraction and identified it as a problem. One user noted that, *"for some reason, i kept looking at the hand-held guide even when it didn't beep, which meant i was less aware of my surroundings,"* another described this problem as one of the benefits of having a human tour guide, *"you are looking more out on the campus than at a small screen."* One possible solution would be to convert the content to audio. Researchers have identified this approach as a way to decrease distraction in tour guide systems [22]. However, delivering content by audio may simply transfer the distraction from the visual to audio channel. Putting a set of headphones on users also has the potential to prevent users from interacting with the people around them. In light of these concerns over both audio and visual distraction it makes sense for designers to consider both options. Audio output may be preferable when the user wants to be looking at something in their surroundings, visual output may be preferable when the user is trying to interact with the people around them. A combination of the two might also be appropriate.

We believe that pushing information at users rather than allowing them to access it at will may have lead to distraction by removing user control over where and when to focus their attention. Users had to wait for information to appear on the PDA screen so they focused their attention on this waiting task, rather than on their surroundings. Unfortunately, the audio alert did not seem to relieve users from the waiting task as we had hoped. Many existing tour guide systems require users to explicitly point and click at an object of interest to gain information. This solution allows users to access relevant information when they want to rather than pushing it at them as soon as it

becomes available. This would allow users to maintain more control over where they focus their attention.

4.3 Evaluating the Social Aspects of Campus Aware

One common goal running through our mobile computing research is finding ways to make systems more social and evaluating the success of these efforts. We believe that systems with a social element are often more dynamic, and a better reflection of user concerns. Putting user-created content in a tour guide can result in a more authentic reflection of the space that is being toured. This is particularly true when users are a cross-section of individuals with different relationships to the space including both space experts and novices. This ties into context-aware computing because the people who regularly visit a space know all about how and when the space gets used and who inhabits it. What they say in and about the space reflects that understanding. Another benefit is that user-created content gives users more power over the system allowing them to steer it's use towards their own needs and interests. Systems that provide these capabilities allow people, "to collectively construct a range of resources that were too difficult or expensive or simply impossible to provide before…" [19]

We believed that the content users contribute is likely to be qualitatively different from the factual information an institution like a museum or university administration would develop. The creators of GeoNotes a location-based social information system were thinking along these lines. They note that the "social, expressive, and subversive," qualities of content created by users may be more interesting than content created by administrators which "tends to be 'serious' and 'utility oriented'" [9]. We attempted to test these assumptions in our evaluation of Campus Aware by analyzing the user created notes for content themes.

4.3.1 Qualitative Analysis of Note Content

One of the most surprising results of our evaluation of Campus Aware was the quantity of information that users contributed to the system. Each user toured around campus with the system for thirty to sixty minutes. In that amount of time, users, on average, left 3.7 notes, with an average note length of about 73 characters. After the initial evaluation, users had collectively contributed 129 new notes. To put this in context, the same number of users contributed about the same number of notes to the E-graffiti system over the course of an entire semester of use.

While the majority of these notes were factual (70 notes), a comparable number (59 notes) were opinions or advice. These opinion/advice notes represented a departure from what is normally associated with a traditional tour. Users felt leaving this kind of note was important, and perceived that it would be valuable to prospective students. As one user noted: *"i want other students to try out some of the fun things i did on campus but was never told about when i went on the tours."* Another interesting category of notes were the "snapshot notes." 33 notes users contributed described the kinds of activities that occur in a space. For example, one user created the following note, "*Day hall is the center for most of the administration done on campus. Many times throughout the year socially conscious students may hold demonstrations outside this hall."* These types of notes work towards giving the

environment a sense of activity beyond what users can experience in the limited period of time when they are visiting a location.

Table 1. Categorization of notes posted by users to the Campus Aware system. Note that when we evaluated the qualities of the user notes some notes fell into multiple categories.

Note Category	# of notes	Examples
Factual	**70**	"This is the agricultural library"
Opinion/Advice	**59**	"A great place to study or take a nap under a tree"
Snapshot	**33**	"this is where our men's and women's soccer teams live, sleep, practice and compete."
Humor	**12**	"this view has made proud men cry with abandon for their mommies"
Questions	**4**	"who practices on these fields?"
Test/Error	**4**	"these groups of buil…"

4.3. 2 Reaction to User Contributed Notes

Opening up a system to user contributions holds the promise of content that is much more informal, opinionated, and even more subversive than content provided by an official source. Our evaluation of the types of notes users contributed demonstrates that this holds true with the Campus Aware system. However, do users value reading this type of information? Survey responses to Campus Aware show that many users do value the informal, opinionated and often humorous information posted by other users. One user commented, *"notes that kind of gave an 'insider's' perspective were quite interesting."* Another user said, *"I found the other personal, insider' notes from other students useful and informative."* A third user stated, *"I think when people come on a tour, the thing they are looking for is not only information about the school, but real advice from the students who go there."* Notes contributed by an unofficial source such as students or other insiders were valued more than the official factual notes that were posted. The content became qualitatively unique and was well-received when it was created by other users. This evidence provides justification for opening systems to this type of user feedback.

4.3.3 Motivation Behind User Contributions

Research in the field of Computer-Supported Cooperative Work has looked at the problem of motivating users to contribute, particularly in groupware systems. One problem results from the "disparity between those who will benefit from an application and those who must do additional work to support it." [12] Alan Cooper calls this the principle of commensurate effort which states that users are willing to work harder when they feel they will be rewarded [6]. Dieberger notes that in social

navigation systems where users share information to guide each other that, "a virtual community consisting only of consumers will not be successful" and that when users are short on time or competing against each other people may be unwilling to contribute [8]. Trying to create a balanced, active virtual community with both information creators and consumers was one of our concerns in designing and evaluating Campus Aware. Since users seemed so willing to contribute notes to the system we wondered what motivated them to do so given that there was no obvious benefit? Analysis of the posted notes and survey results we gathered point to several possible answers.

Some of the notes posted on Campus Aware suggest that being in the relevant environment jogged the user's memory. As one student commented, *"If I saw something not on the program I added it."* Another example is a note a user posted reading, *"Don't park on the road here. Tickets are $45.00."* Seeing the location where the incident happened reminded the user of the parking ticket and they posted a note about it as a result. It's unlikely that they would have posted this comment if they weren't actually near the physical location where the event occurred.

Above all, users seemed most compelled to contribute when they thought themselves experts. *"I thought I had some interesting point of views and additional info to contribute,"* one user noted. Another stated, *"I felt it was important that others should be aware of certain things."* In fact, when asked why they left notes, over half of the participants answered that they felt they had information that was missing from the system or they thought their views would be useful to future users. It seemed to be this desire to express an opinion or help others out that drove these users to contribute.

Users are motivated to contribute when there is a pay off or when it is very easy to do. As we noted in the previous section about user reaction to posted notes, users found value in the information posted by other experts, so this was one payoff for them. They also seemed to have benefited from feelings of altruism and expertise resulting from contributing notes to help out others. These experts were willing to create notes even though it was difficult to do on Palm Pilots. However, in a real-life scenario where users don't have time set aside to use the system other options have to be provided. We recommend easier input methods such as "social maps" and a desktop based annotation system to encourage participation among experts. This will help to maintain a balance between experts and novices in the virtual discussion.

4.3.4 Note Accuracy, Note Quality, and User Moderators

A number of problems emerged with the notes users-created primarily stemming from the fact that people are unpredictable and our system relies heavily on their contributions. Getting users to contribute at all can be problematic, and assuring that users contribute content that is both accurate and meaningful is also difficult. Accuracy is one of the open issues for social navigation, "while a recommendation from an expert might be more valuable, because one can be sure the information is correct, it may be harder to get that information." [8]. When a system becomes open to general comments from users there's the risk that information may be inaccurate. Accuracy was a problem with a few of the notes on Campus Aware. Other users noticed this, *"...it tells you how to get tickets even though that information was incorrect"* It's interesting to note that later users often observed these inaccuracies

and then posted corrections on the system. For example, one user posted information about obtaining tickets for hockey games and a later user posted a note stating that this was no longer the procedure. A system of checks and balances emerged to resolve accuracy issues. The useful role of mediators emerging from the general user group to aid, improve, and guide use of the system has been documented in other research [16]. Our evaluation of Campus Aware shows that users emerged once again to improve the overall accuracy of notes posted to the system.

Note quality was another issue. While many notes were unique, interesting, and useful, others were not. In particular, someone started a thread of notes by stating *"sushi is good except for msg in wasabi and ginger."* In a number of survey replies users commented on how pointless these types of messages are. It is difficult to determine whether the notes users post are of high quality unless someone is assigned to moderate the content and even then it is a subjective judgment. Notes of low quality, if there are enough of them, can potentially turn users off from the system. Allowing users to vote on the usefulness of notes themselves is a possible solution to this problem. Various websites such as Slashdot, Amazon, and E-bay provide similar capabilities. Our findings on accuracy show that users are willing to play the role of moderator and are likely to use this note voting functionality.

4.4 Evaluation of Context-Awareness Features of Campus Aware

As researchers have pointed out, "…the goal of context-aware computing should be to make interacting with computers easier. Forcing users consciously to increase the amount of information is more difficult for them and tedious." [7] Are we missing this point be advocating users as content creators to a context-aware system? We argue no; that by distributing this work among a large number of users who only contribute a small amount a huge store of information can be effortlessly created to benefit many later users. Additional approaches to gathering information from users that require less effort (such as behavior data and simple voting forms) can also be utilized. Yet even providing a usable system with more well established context-awareness features is not easy. Determining which aspects of context are important to detect is a challenge to anyone trying to design a context-aware system. In our evaluation of Campus Aware we discovered a few aspects of the user's environment that we did not detect, but were important to their context of use. This led to some confusion among users, even those who were well acquainted with the campus.

4.4.1 Location is More Than Coordinates

User survey responses demonstrated confusion over the correlation between notes and physical objects in the environment. One might think that establishing a users location especially outdoors is simply a matter of placing text notes at appropriate GPS coordinates. However, users commented that *"Sometimes I was a little confused about what building/area the notes was talking about,"* another user noted, *"A lot of times, a note would pop up that would describe a building, but it wasn't clear where the building was with reference to my position. For example, I was standing between two buildings, and a note popped up for the BioTech building. Which of these two buildings is the BioTech ba*

uilding?" In particular, orientation plays an important role in determining the users context. In combination with location can determine more precisely what the user is paying attention to. Since our system did not detect orientation it was possible for users to get notes about buildings that were behind them. This was confusing even for users who were well acquainted with the campus.

The timing of note appearance was also important as one user commented, *"several times I would be well past a landmark before a note would pop up."* Another user noted, *"in certain places...i was given too much info and didn't have a chance to read it all as i walked because it disappeared too quickly."* A note about a building that appears as the user is walking away may well be within the twenty foot default range, but the users has mentally moved on. Ideally, knowing the users rate of travel can help establish when is the optimal time to display a relevant note. Note persistence is another feature that could be useful in conjunction with rate of travel. This setting would make sure that any note was listed for a certain minimum amount of time.

4.4.2 Touring is More Than Learning About a Place

Based on user comments we learned that another aspect of context that was important for users of our system was activity. When we designed the system we assumed that there would essentially be one activity supported, namely touring. This seemed narrow enough to be easily supported. What we neglected to notice was that touring can be further divided into at least three activities learning, planning, and navigating. While learning the goal of the user would be to find out more about the environment immediately around them; whatever they can see. While planning goals such as figuring out where to eat lunch, or determining what they can manage to see in the next hour would be important. While navigating the user's goal would be to find a certain building, a great view, or a specific department.

User surveys show that navigating and planning were not well supported by Campus Aware. One user expressed a desire for *"directions from one place to another… you put in where you want to go and it gives you directions as you're going there,"* another commented that "*suggestion of tour routes maybe useful, because i find myself kinda just wandering around without a specific tour route"* While Campus Aware provided information about a very narrow framework of time and space (current time and current space within about 20 feet), the necessarily broader framework of time and space (in the next few hours or days and covering the entire campus) needed for planning was not provided. Similarly navigation was not supported because the content of the notes dealt only with the current location and not with directions to other destinations outside of the users visual range. Users complained that the information provided didn't give them any idea about where to go next. It should also be noted that users did not take the initiative to create this type of navigational information though they were knowledgeable enough about the campus to do so. All the notes that users wrote dealt exclusively with the learning activity. A good solution to this problem would be a campus map showing user location and/or directions about where to go next. This was the most requested feature for future versions of Campus Aware.

5 Conclusions and Future Research

This project demonstrates that incorporating user-contributed information into a context-aware tour guide is a valid way to generate useful content. In our study users were willing to contribute their knowledge and also found value in the content created through this process. We also noticed that when users posted inaccurate information other users posted corrections and when users posted questions other users answered them. The self-maintaining nature of our system is encouragement for designers of similar systems who are concerned about the quality and accuracy of unmoderated content created by users. Next we hope to begin evaluating the concept of social maps. These maps take aggregated user behavior or very simple user feedback (such as voting on locations) and map this information onto physical spaces. We are interested to see how user behavior might change when given access to these maps. We hope to implement a social mapping system as part of a tour guide that will help users get to interesting information. Other issues we would like to address in future work include scalability of the system, use of the system by a variety of different user populations, and use of similar systems in other environments.

5.1 System Scalability

One of the major issues we did not address in the evaluation of Campus Aware was scalability. As the number of users contributing notes increases problems would result from a simple overabundance of information. A visitor touring a college campus would most likely only have the time to read a few notes at each location. Ideally those notes would be interesting and relevant. One way to accomplish this is to take the user's profile including nationality, age, occupation, or many other characteristics and filter the notes for authors with similar backgrounds. However filtering based on affiliation is problematic. Who knows whether or not a user wants to hear from someone just like them, or from someone with a completely different perspective? A certain element of serendipity could be a valuable quality to preserve in systems like Campus Aware. And sometimes a user profile will not filter out enough information. For example, filtering for notes written by 20 year old college students in a system like Campus Aware would do very little to limit the amount of information being presented to the user. Another approach would be to allow users to rate notes. This technique is used today on websites such as Amazon.com and Slashdot.org. Notes with high ratings filter up to the top of the list. This is a useful strategy because it does not prevent users from accessing any information, but makes some information more easily available since it is generally agreed upon as being useful and interesting. In a future version of Campus Aware we would like to test these and other filtering approaches to determine which ones are the most successful at keeping users interested in the system without limiting the scope of information they receive to a overly narrow range of ideas and perspectives.

5.2 Use of Campus Aware By Other User Populations and in Other Environments

We have just begun testing Campus Aware with prospective students to see how their use of the system differs from the undergraduates. The undergraduate experts were eager to share their vast amount of accumulated knowledge about the campus. We expect that prospective students will use the system in very different ways. In terms of content, we expect them to contribute far fewer notes since they do not have the same level of knowledge about the campus. However, we expect them to post more questions. We also believe that they will be very appreciative of the notes posted by undergraduates about the campus and college life in general. In terms of successfully using the system we believe prospective students will express more frustration and confusion over the lack of navigational features and the imprecise nature of location-detection.

Users suggested a number of other environments they thought a system like Campus Aware would be useful including city tours, museums, malls, zoos, and national parks. One user suggested using it as a tool for the military that would aid in tagging dangerous areas with warnings. In the future we hope to do a third iteration of this system in one of these suggested settings to see how needs change with a different group of users who have different interests.

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