Study and Redesign of a Semi-public Display: Online Enlightenment

Cyril Montabert, Rahul Agarwal, Christine Lee, and D. Scott McCrickard
Center for Human Computer Interaction and Department of Computer Science
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061 USA
{cmontabe, rahulaga, chlee2, mccricks} @ vt.edu

ABSTRACT
Semi-public displays are systems designed to strengthen awareness and collaboration among small co-located group environments. Placed in a semi-public space, Online Enlightenment is a physical device associated with MSN® Messenger to provide information regarding the online status of peers. The raison d'être of the system is to leverage group members' awareness of their peers' availability through changes of their online status in order to facilitate meeting scheduling, promote opportunistic collaboration, and foster project teamwork without introducing distraction. At an early stage of the development process, this paper presents the results of a usability study of the system and proposes a redesigned mock-up to address the identified deficiencies.

Author Keywords
Semi-public display, notification system, phidget, usability study, interface design.

ACM Classification Keywords
H1.2. Models and principles: Human factors; H5.2. Information interfaces and presentation: User interfaces.

INTRODUCTION

The last decade has seen the widespread use of instant messengers for a variety of purposes. With the integration of instant messengers into laboratories and workplaces, the challenge becomes finding the balance between providing sufficient information to maintain awareness and encourage collaboration, while respecting privacy and not introducing distraction [1]. *Online Enlightenment* is a physical device associated with MSN® Messenger, which provides information about the online status of peers in order to promote group awareness in a non-intrusive manner [6]. The goal of our work is to evaluate how useful the system is to laboratory members and identify areas of improvement in terms of supported features and information displayed. Using a combination of video footage, system use log, demographic questionnaire, heuristic evaluation, and semi-structured interviews, we unveiled critical deficiencies associated with the device that we address with the prototype we are presenting.

RELATED WORK

The use of instant messengers has become more prevalent in recent years, as home and school emphasis on computer use has provided the initial and often necessary conditions for the widespread adoption of the technology. Moreover, the need to socialize and belong to a group coupled with instant messengers' low disruptive behavior to the domestic environment has made the infrastructure appealing and contributed to its acceptance [3].

To collaborate more efficiently, users need to maintain awareness of their colleagues' availability effortlessly [4]. In their 2003 paper, Tang and Begole introduced the concept of awareness services to describe possible future services going beyond text chat, providing users with a better sense of presence. One of their research prototypes examines awareness information over time to predict future contact availability, while another incorporates awareness information from various sensors to infer when colleagues may not be available for interaction [14]. Nonetheless, the major recurring concern involves how to provide information without being obtrusive or disruptive.

The advent of new multitasking informational applications, such as stock tickers, task-bar icons, and in-vehicle displays, is a response to users' needs to track information while not being unnecessarily distracted from their primary task. These secondary software applications that fulfill user's information needs are referred to as notification systems, interfaces designed to disseminate valued information, in an efficient and effective manner, without introducing unwanted interruption to a primary task [12].

With this idea in mind, Isaacs *et al.* motivate the need for portable, non-intrusive communication systems that allow distributed work groups to keep track of one another. In fact, they argue that traditional instant messengers enable merely a minimal awareness of people's environment. It is possible to know when users log on or log off since most systems will typically play a sound in response to such events, but it is much more challenging to spot the aforementioned contact without glancing at the interface. In addition, there is only visual support to identify the

availability of contacts. To resolve these issues, they introduce a mobile instant messaging system—Hubbub. As a novelty, Hubbub offers meaningful earcons and visual signals to indicate users' changes of status, while allowing sound overload control [9]. Through an evaluation of their system, the authors identified three critical elements for a successful distributed collaboration: "awareness, opportunistic conversations, and mobility" [8].

Providing awareness without intrusiveness or distraction is an issue whose solution has yet to be fully framed. To foster collaboration and facilitate scheduling within a laboratory environment through group awareness, Virginia Tech's Notification Systems Laboratory developed Online Enlightenment. Online Enlightenment was crafted as a semi-public display, a concept introduced by Huang and Mynatt, with the idea that semi-public displays benefit small, familiar groups [7]. Instead of using a traditional computer representation like Huang and Mynatt's semi-public displays, Online Enlightenment moves away from the desktop, and alternatively, relies on phidgets technology to create a real-world interface. Similar to widgets in a traditional graphical user interface, phidgets or physical widgets are the constituents of a physical user interface [2]. They include physical buttons and other user-controlled devices capable of acting upon software components. In their research, Harrison and Dourish explored the use of spaces as a foundation for CSCW design. Aspects of the real world, such as proximity and action, as well as presence and awareness, may be referenced as part of a spatial model for collaboration. According to the authors, an "understanding of proximity helps … relate people to activities and to each other". Online Enlightenment seeks to provide an understanding of proximity by non-intrusively supplying information about laboratory member status so that inferences may be made about people's presence and activities. Additionally, Harrison and Dourish also noted that a "sense of other people's presence and the ongoing awareness of activity allows us to structure our own activity, seamlessly integrating communication and collaboration ongoingly and unproblematically" [5]. As an ambient display [10, 15] located in a semi-public space, Online Enlightenment enables people walking by or meeting in the conference room to maintain effortless awareness about laboratory members' availability and activity through changes of their online status (Figure 1). Using the system, users may also know when to approach other laboratory members, supporting appropriate behavioral framing or the ongoing management of activities in collaborative settings [5].

The system uses MSN® Messenger's log file to display laboratory members' online activity. The interface consists of a physical board representing a map of connected laboratories. Laboratory members are represented by a caricature and a first name (for privacy reasons), placed on the board consistently with the spatial location of their desk. Under each caricature, a light-emitting diode (LED) models the online status:

- A turned-on LED means a person is online, either physically present in the laboratory or remotely connected, or that a person is away.
- A turned-off LED represents an offline status.

To obtain more information about laboratory members' status, a press on their caricature sends their online status, as well as the timestamp associated with their last status change onto a liquid crystal display (LCD) screen located at the top of the board. Preliminary studies have shown that the system allowed users to infer others' work patterns, helping them plan meetings and other interactions.

Our interest in this study resides in the fact that numerous attempts to maintain awareness of people's activity have failed because of inappropriate levels of intrusiveness, lack of features, or both.

USABILITY STUDY

To conduct our usability study without affecting the laboratory work and social environment, we first observed people's behavior by monitoring their interaction with Online Enlightenment. We set up a log file to keep track of users' physical interaction through button presses, while simultaneously videotaping users' actions. After review of the video footage, we invited users to participate in questionnaires and interviews.

Pre-test Observation

We first maintained a log file for five consecutive days to capture user activity on the system. The log file recorded people's online status triggered by button presses. The log file highlighted that the laboratory activity occurred mainly during the afternoon, from 12 p.m. to 6 p.m. Consequently, we performed video recording throughout that timeframe. Over a three-day period (Tuesday – Thursday), we recorded over 750 minutes of video footage. The video camera was set up facing Online Enlightenment, at a distance of approximately eight feet. This was the optimal distance given the laboratory's configuration for a video angle to capture the system on the left and the hallway on the right, without being obtrusive to people. Not only did this setup enable us to identify users interacting with the tool, but it also permitted us to discover that many laboratory members were only glancing at the system instead of physically interacting with the device. The video footage also proved useful for reconciling the content of the log file with the people querying the system.

Testing Procedure

To evaluate whether the system was supporting awareness of laboratory members' activity without being intrusive to the work environment, we opted for a heuristic evaluation to analyze its interface. In fact, this usability testing technique is easy to perform, inexpensive, and can be done with few participants, while providing clear and immediate feedback about the system. Previous studies have shown that the optimum cost-benefit ratio for heuristic testing is from three to seven evaluators [13]. To evaluate the

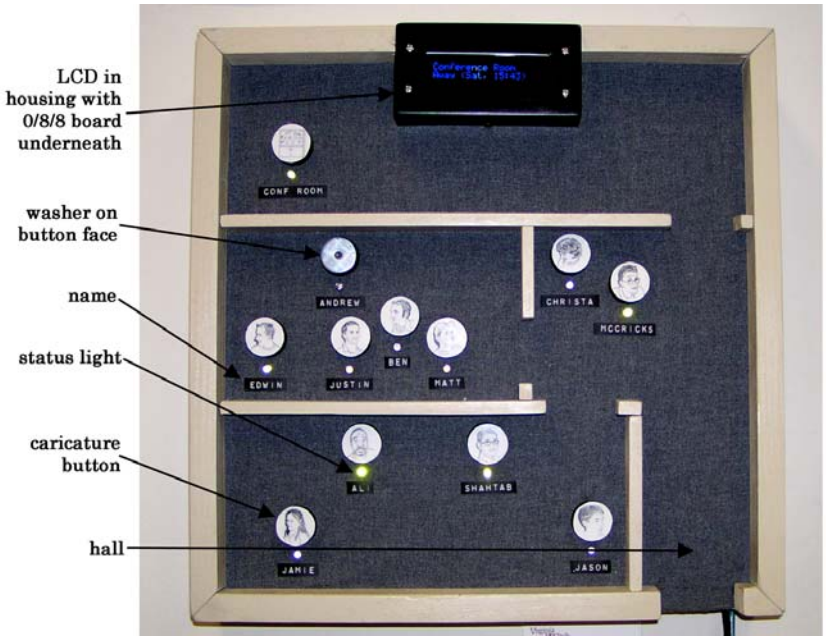

Figure 1. The Online Enlightenment system

interface with the target user group, we tested seven laboratory members encompassing the full scope of university roles—Faculty member, Doctoral and Master's candidates, as well as Undergraduate students—a cross section of the laboratory's population.

The study consisted of a demographic questionnaire encompassing basic information such as major, university role, age, and gender. Five questions established the participants' involvement in the laboratory's activities, dependence on other laboratory members for their work, interest and acceptance of new technologies, as well as their reliance on collaborative work technology in their work and life.

Participants were then asked to complete a questionnaire for a heuristic evaluation of the system, using a set of refined heuristics better suited for ambient display evaluation [11]. To avoid bias, statements referring to similar heuristics were uniformly spread out throughout the questionnaire. In addition, the tone of statements (*i.e.* affirmative vs. negative) was similarly varied.

After completion of their questionnaires, the evaluators were invited to participate in a semi-structured interview, throughout which they could give comprehensive feedback about their appreciation of the system, in terms of ease of use, supported functionality, displayed information, appeal, and overall satisfaction.

Results

After running the experiment, we analyzed the results of the demographic questionnaire, heuristic evaluation, and semi-structured interviews. Our Likert scale consisted of five answers: strongly disagree, disagree, neutral, agree, and strongly agree. Each of the answers was assigned a corresponding numeric value from one to five, a response of "strongly disagree" having a value of one, and a response of "strongly agree" having a value of five. We averaged the numeric values for each question and calculated the standard deviation.

Demographic Questionnaire

The demographic questionnaire showed that all participants were strongly involved in the laboratory's activity. Furthermore, they acknowledged their dependence on other laboratory members for their work, and to that extent, rely on cooperative tools. The evaluators showed enthusiasm for new technologies (Figure 2).

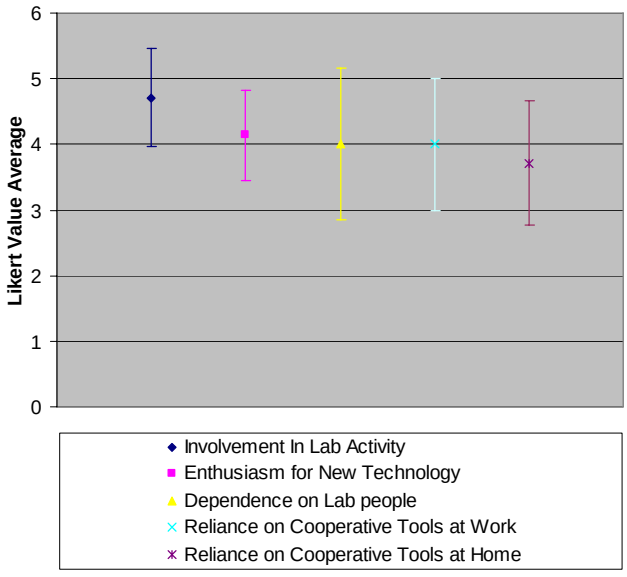

Figure 2. User agreement ratings for the demographic questionnaire (average +/- standard deviation)

Heuristic Evaluation

Consisting of sixteen questions, the heuristic evaluation focuses on specific aspects of the interface. A value greater than three means that the interface somewhat meets its design goals. Conversely, a value less than three indicates a deficiency of the interface for that area. A value of three represents a neutral response.

The results of the heuristic evaluation (Figure 3) showed the information displayed is lacking in terms of usefulness and relevancy (M=3.29, SD=1.38—somewhat low mean and strong standard deviation). To that extent, the system does not convey enough information (M=2.48, SD=0.94), and people have difficulty obtaining more information (M=2.57, SD=1.51). Finally, the current interface does not maintain proper visibility of status change (M=2.57, SD=0.79), and the peripherality of the display is not easy to monitor (M=3.17, SD=1.19—somewhat low mean and somewhat strong standard deviation).

The interface meets its objective in terms of mapping and metaphor (M=4.07, SD=1.05), properly blends in its laboratory environment (M=4.14, SD=0.69), and is judged aesthetically pleasant (M=3.57, SD=1.27).

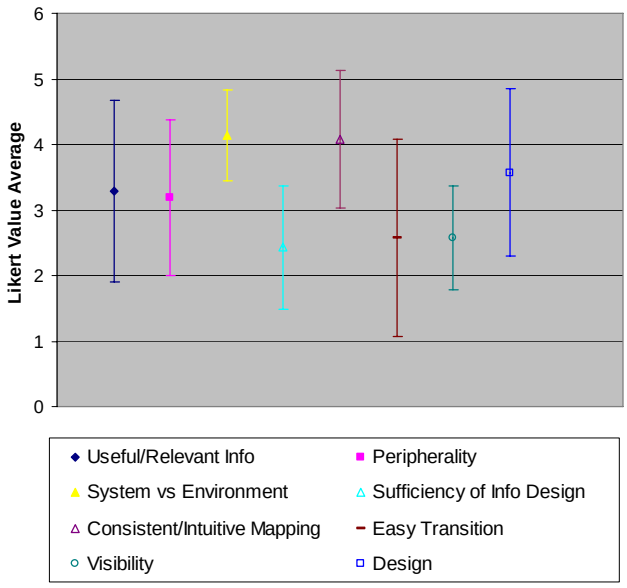

Figure 3. User agreement rating for each of the evaluated heuristics (average +/- standard deviation)

Semi-structured Interviews

Users were broken down into three categories based on whether the video footage identified them as physically interacting with the system, just glancing at the device, or simply ignoring it. Each user category was presented with a set of standardized questions tailored to their corresponding use of the system. Interestingly, users from each category shared identical opinions about the system and suggested similar changes, confirming the findings of our heuristic evaluation.

Users categorized as physically interacting with the device primarily do so to infer whether and when people can be expected to be back, based on the timestamp of their away or offline status. Similarly, these subjects also infer people's work patterns, by observing trends of offline activity. These users suggested that displaying information about the away status, as well as a "be right back" status would make the system more useful.

Users identified as only glancing at the system primarily do so on their way in or way out of the laboratory, to see who is most likely physically present. They do not feel the need to interact with the system, as they judge the information displayed to be neither accurate nor relevant. This type of users would like a differentiation between a person online and a person online but away, without introducing intrusiveness. In fact, the current system uses a single LED to model both statuses. Similarly, they would like a differentiation between people locally and remotely connected. Finally, these users would like further features than what MSN® Messenger already supports, such as an anticipated time back, meeting time, or the ability to contact all the people present on the board at once.

Participants captured on the video footage as ignoring the system are not strongly involved in the laboratory's projects, and consequently do not rely on other laboratory members to accomplish their tasks. This category of participants admitted they did not understand what that system was doing, failed to identify buttons under the caricatures, and did not feel it was something they were "allowed" to touch.

The conducted usability study on Online Enlightenment, through observation, heuristic evaluation, and semi-structured interviews of everyday users, showed the system succeeded in some ways, while the feedback highlighted areas for improvement. The laboratory members share a high expectation about Online Enlightenment's potential usefulness, although in its current state, the system clearly does not support enough relevant and useful information.

PROTOTYPE DESIGN

To address the issues identified in the usability study, we conducted a redesign of the system. To support and emulate the physicality of the system in our redesign, we decided to create a Flash® implementation of the system to be displayed on a touch screen. Not only would a computer-based design eliminate the need to rewire or drill holes on the actual physical board, but it would also allow for easier modification as we go through several iterations to determine a proper solution. Some of the processes we used to formulate solutions to specific problems included brainstorming, sketching, storyboarding, iteration, and refinement.

Layout and Visibility of Status

The usability study revealed that the users deemed the interface in its current state as aesthetically pleasing and properly blending into the environment by not causing

unnecessary distraction. Consequently, we decided to preserve its overall layout and colors. Moreover, because laboratory members are familiar with the spatial desk arrangement, the laboratory's map representation enables them to identify coworkers instantly on the board. Lastly, representing laboratory members by caricature and first name only allows people to identify users while meeting the privacy comfort level of all laboratory members (Figure 4).

To offer a proper visibility of status, we wanted the interface to support a differentiation between various online statuses—online locally, online remotely, online but away, offline—as opposed to a single LED modeling all statuses. An option was to use a fading-light metaphor to model user proximity (a person online locally being perceived closer than a person online but remotely connected, which in turn would be closer than a person away). This approach while intuitive might introduce confusion, especially when the user has no reference point for light intensity [4]. Consequently, we opted for the use of multiple colors to differentiate each status, but informal testing among laboratory members failed to establish a universal intuitive color code. A consensus was to create indicators consisting of an icon backlit by a colored LED.

- A disc reading "IN" backlit in green models an online locally status
- A satellite-dish icon backlit in orange models an online remotely status
- A "wrong-way" icon backlit in red models an online but away status
- All indicators turned off simultaneously represent an offline status

To draw attention when a user changes status, the icon modeling the new online status slowly blinks twice, while the icon associated with the previous status remains lit. Once the blinking ceases, the new icon stays lit while the previous icon turns off.

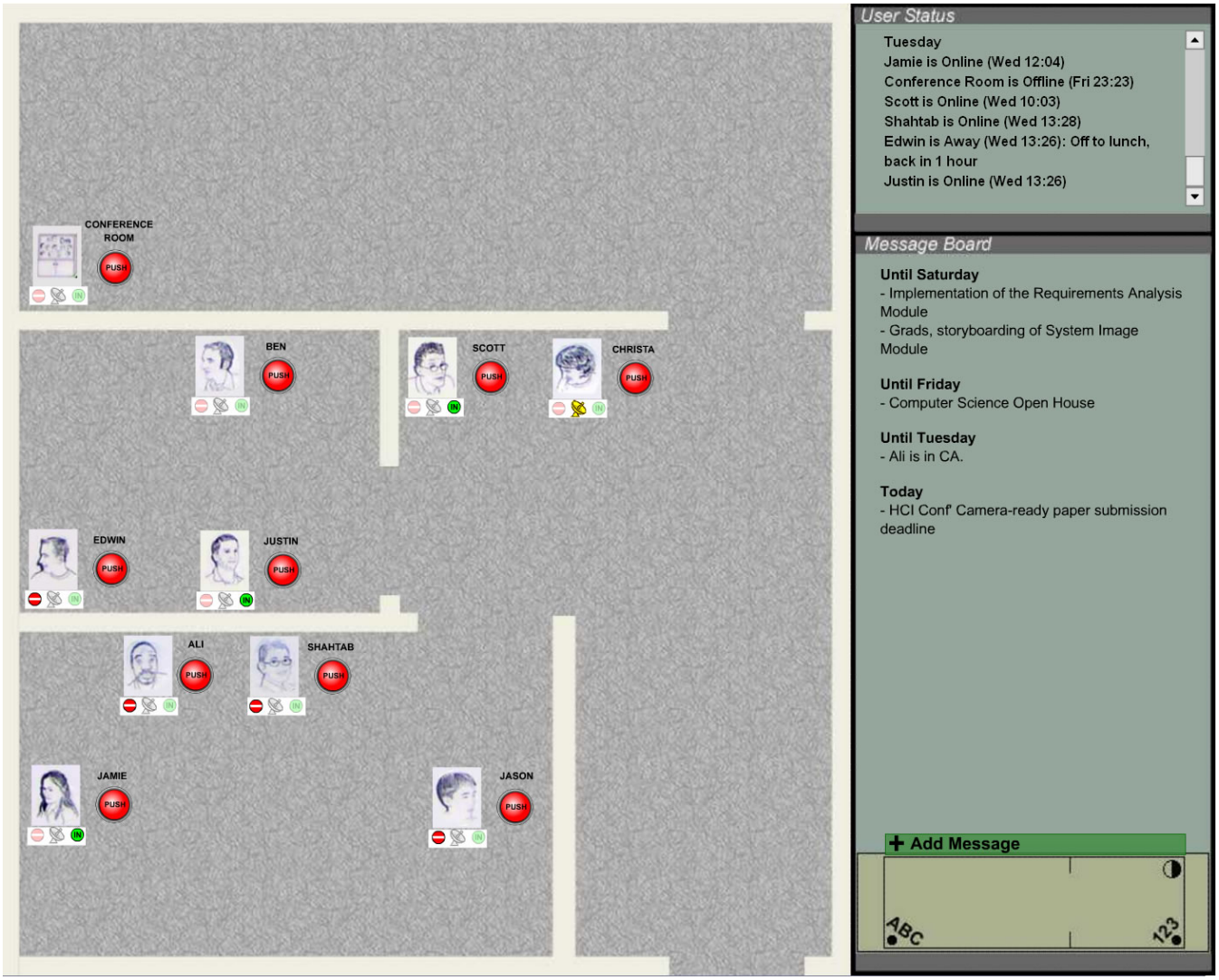

Figure 4. Prototype layout

To make buttons more noticeable and give the system a more inviting feel, especially for laboratory visitors unfamiliar with the system, we separated all of the buttons from their overlapping caricatures and made them large, red, and cartoon-like (Figure 5).

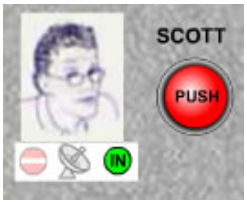

Figure 5: Close-up of user rearrangement

Away Messages

In our redesign effort, we maintained the display of the online status and timestamp triggered by button presses. To improve the usefulness and relevancy of the information displayed regarding an online but away status, our redesign includes additional information in the form of away messages and anticipated return time provided by the user. To maintain privacy based on a user's comfort level, the system offers default away messages, while custom away messages are also supported.

Furthermore, the redesigned interface enables a user to access a history of online-status activity by incorporating a scroll bar in the user status panel (Figure 6). Accessing past events helps users to infer patterns of online activity. For example, the user status panel shows "Christa is Offline (Wed 13:27)" and Scott would like to know how long she stayed online. By pressing the scroll bar, he is able to obtain that she connected remotely at 13:00.

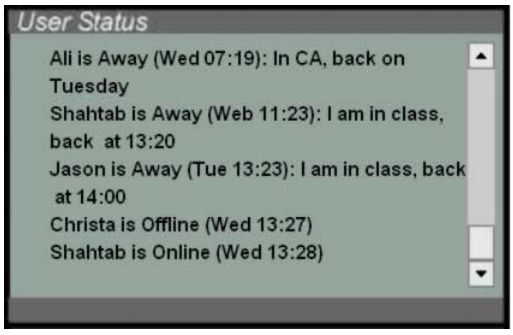

Figure 6. User status panel

Message Board

To make the system more useful in terms of supported functionalities and to capitalize on the group viewing capability, the prototype includes the addition of a message board. In their study, Huang and Mynatt used a similar type of shared announcement, which proved useful to "maintain awareness of group members' day-to-day work status as well as for getting help with both short-term and long-term tasks because the requests were constantly viewable in the environment" [7].

A message board panel, located on the right side of the physical board, allows laboratory members to post general announcements. Similar to a PDA, users can enter new messages by writing graffiti® characters with a stylus. When adding an announcement, users are required to give a lifespan to the message by selecting an expiration date. This feature ensures the relevancy of the posted messages (Figure 7).

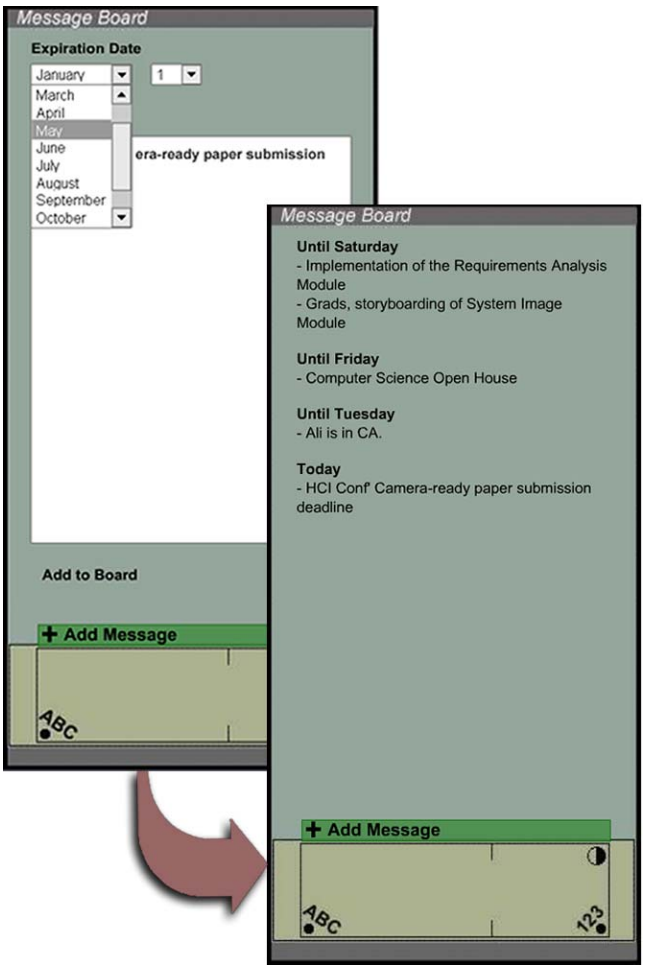

Figure 7. Posting on the message board panel

CONCLUSIONS AND FUTURE WORK

We expect our prototype to address the issues identified during the usability study we conducted. The next step would be to conduct yet another usability study in order to obtain feedback on the usefulness of the system and to determine whether the issues originally identified have been properly addressed. After further design iterations based on usability studies and user interviews, the prototype may be translated back onto the physical Online Enlightenment display, where the additional touch-screen message board may be attached in the form of a tablet PC or handheld device, and a larger scrollable user status display may also replace the existing LCD. Other alternatives for future widget-based prototypes may include building Online Enlightenment using LEGO®, Styrofoam, or other materials that provide flexibility for change.

Another interesting research question for future study may be the effects of different placements of the system within the laboratory. Through the modifications we brought to the system, we foresee that Online Enlightenment will support enough relevant and useful information to fuel its widespread acceptance while maintaining its unobtrusive, ambient nature.

ACKNOWLEDGEMENTS

The authors would like to thank all the people who participated in that study, for their time and efforts. We also want to extent our appreciation to Dr. Deborah Tatar for her highly valuable feedback.

REFERENCES

1. Dourish, P. and Bellotti, V. Awareness and coordination in shared workspaces. In *Proc. of the 1992 ACM Conference on Computer-Supported Cooperative Work (CSCW '92)*, ACM Press (1992), 107-114.
2. Greenberg, S. and Fitchett, C. Phidgets: Easy development of physical interfaces through physical widgets. In *Proc. of the 14th Annual ACM Symposium on User Interface Software and Technology (UIST '01)*, ACM Press (2001), 209-218.
3. Grinter, R. and Palen, L. IM Everywhere: Instant messaging in teen life. In *Proc. of the 2002 ACM Conference on Computer Supported Cooperative Work (CSCW '02)*, ACM Press (2002), 21-30.
4. Gutwin, C. and Greenberg, S. A descriptive framework of workspace awareness for real-time groupware. *Computer Supported Cooperative Work 11*, 3 (2002), 411-446.
5. Harrison, S. and Dourish, P. Re-placing space: The roles of place and space in collaborative systems. In *Proc. of the 1996 ACM Conference on Computer Supported Cooperative Work (CSCW '96)*, ACM Press (1996), 67-76.
6. Heir, M., Hoon, H., Terrell, G., and McCrickard, D.S. Online enlightenment: A phidget notification system for online status. Technical Report TR-04-30, Department of Computer Science, Virginia Polytechnic Institute and State University (2004).
7. Huang, E. and Mynatt, E. Semi-public displays for small, co-located groups. In *Proc. of the SIGCHI Conference on Human Factors in Computing Systems (CHI '03)*, ACM Press (2003), 49-56.
8. Isaacs, E., Walendowski, A., and Ranganathan, D. Hubbub: A wireless instant messenger that uses earcons for awareness and for "sound instant messages". In *CHI '01 Extended Abstracts on Human Factors in Computing Systems (CHI '01)*, ACM Press (2001), 3-4.
9. Isaacs, E., Walendowski, A., and Ranganathan, D. I think, therefore IM: Hubbub: A sound-enhanced mobile instant messenger that supports awareness and opportunistic interactions. In *Proc. of the SIGCHI Conference on Human Factors in Computing Systems: Changing Our World, Changing Ourselves (CHI '02)*, ACM Press (2002), 179-186.
10. Ishii, H. and Ullmer, B. Tangible bits: Towards seamless interfaces between people, bits, and atoms. In *Proc. of the SIGCHI Conference on Human Factors in Computing Systems (CHI '97)*, ACM Press (1997), 234-241.
11. Mankoff, J., Dey, A., Hsieh, G., Kientz, J., Lederer, S., and Ames, M. Heuristic evaluation of ambient displays. In *Proc. of the SIGCHI Conference on Human Factors in Computing Systems (CHI '03)*, ACM Press (2003), 169-176.
12. McCrickard, D.S. and Chewar, C.M. Attentive user interfaces: Attuning notification design to user goals and attention costs. *Communications of the ACM 46*, 3 (2003), 67-72.
13. Nielsen, J. Heuristic Evaluation. In J. Nielsen and R.L. Mark (Eds.), *Usability Inspection Methods* (pp. 25-62), John Wiley and Sons, New York, NY, USA, 1994.
14. Tang, J. and Begole, J. Beyond instant messaging: Future awareness features and their technical implications. *ACM Queue 1*, 8 (2003), 28-37.
15. Weiser, M. and Brown, J.S. Designing calm technology. *PowerGrid Journal 1.01*, (1996).