Ambient Interfaces that Motivate Changes in Human Behavior

Jodi Forlizzi, Ian Li, and Anind Dey
HCII and School of Design, Carnegie Mellon University
forlizzi@cs.cmu.edu

ABSTRACT
Peripheral or ambient displays move information from the periphery to the center of human attention and back. Our research group is interested in the interaction and interface design goal of how to best design ambient displays that help users to understand and change their behavior. We have found that there is often a disconnect between a person's perceived and actual behavior, and we hypothesize that appropriately designed ambient displays can address this problem.

Choosing physical activity as our first domain of exploration, we have developed the IMPACT system, which monitors physical activity throughout the day and provides feedback to the user in the form of detailed and abstracted displays. To date, we have explored abstraction and symbols, agents and avatars, and speech and sound user interfaces as display modalities that can present appropriate amounts of information in a lightweight fashion without being too distracting.

INTRODUCTION
People who engage regularly with technology interact with hundreds of visual, auditory, and multimodal displays each day. Some of these displays demand full attention; others can be interpreted with just a glace. The latter set of displays has been described *calm technology,* [7] or *peripheral* or *ambient displays* that move information from the periphery to the center of human attention and back. If we can leverage design methods to reduce the time it takes to extract information from a display, we can focus more quickly on how to design ambient displays that help users become more aware of and ultimately change their behavior.

Ambient displays receive varying and unpredictable levels of attention. Understanding what design variables might minimize the demand for attention, and help people to become more self-aware through information interactions, is a rich area for exploration. While many novel ambient display designs have been proposed for everyday environments [2, 3, 4, 7, 8], most are point designs in a space that have rarely been systematically evaluated for effectiveness or even desirability [6, 1]. Furthermore, little is known about how interactions over time with an ambient display might potentially contribute increased use of peripheral awareness and ultimately, change in human behavior.

Our research group is working on systems that use peripheral displays on context-aware devices to sense and provide information about the self, to improve decision making. and to inspire positive changes in human behavior. We have found in our research that a gap exists between perceived and actual behavior. We reason that an appropriately designed ambient display can deliver information in real time to help people develop a better awareness of their behavior. We believe that the difference between real and perceived behavior can diminish and that real behavior can be improved.

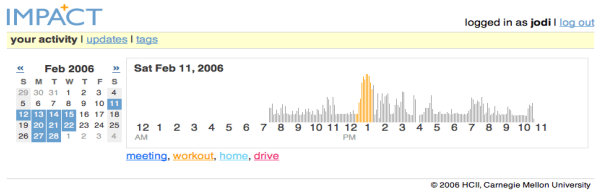

Figure 1. Prototype of a reflective visualization, indicating the amounts of physical activities conducted while performing everyday activities.

Our first domain of exploration has been physical activity. We have created the IMPACT system, which stands for Improving and Motivating Physical Activity Using ContexT. This system monitors physical activity throughout the day and provides feedback to the user in the form of both detailed and abstracted displays. Figure 1 shows a visualization of a day of activity.

We are interested in the interaction and interface design research goal of how to best design ambient displays that help users to understand and change their behavior. We are investigating several design themes, including the use of abstraction and symbols, the use of agents and avatars as peripheral displays, and the use of speech and sound user interfaces as ambient displays.

APPROACH
We have identified a 5-part framework for designing activity monitoring and feedback systems: Activity: what phenomena need to be monitored? Sensing: what is the appropriate technology for monitoring these phenomena? Modeling: How should the sensed data be analyzed and modeled? Feedback: What are appropriate methods for presenting feedback to users? Effect: What is the effect of presenting feedback to users?

Activity: what phenomena need to be sensed?
We have conducted initial ethnographic studies of women who have set goals to lose weight and upheld or failed to uphold those goals. We have also instrumented a randomly chosen subset of our subject pool with pedometers, accelerometers and heart rate monitors. We have learned what barriers exist to being more active, and how data from pedometers is not seen as inherently useful. We also understand how to better contextualize and understand activity.

Sensing: Identify sensing technology
The physical nature of health-related activities poses a challenge to the kind of sensors that will be successful in monitoring activity. Sensors placed on the body need to be non- or minimally intrusive, need to blend seamlessly into the lives of the users, and be inexpensive, accurate, robust and be low-power devices.

Modeling: Detecting trends and progress towards goals
The sensing data collected from our subjects is used to iteratively create models of user activity to better understand hourly, daily and weekly variations in activity over time and how users' self-motivation causes changes in their monitored activity.

Feedback: Identify and evaluate appropriate feedback mechanisms
We are currently working on several types of ambient displays that we hope will provide users with the appropriate information to monitor and possibly change their behavior. These include the use of abstraction and symbols, agents and avatars that look like the user, and speech and sound user interfaces.

Abstraction and symbols
As interface designers, we have been researching how simple and complex interfaces effectively convey information to users. During the workshop, we will use the themes of simplicity, complexity, direct, or indirect symbols to help brainstorm the visual components of ambient displays. For example, Figure 2 shows a comparison of two icons indicating a restaurant: a McDonald's icon and a more generic restaurant symbol. Although the complex symbol conveys more information, it could be potentially distracting if it is not the target of an information interaction. In some contexts, the simple generic (indirect) symbol would be easier to perceive, but may need to be decoded to offer the right amount of information. On the other hand, indirect, highly abstract symbols can be useful for preserving privacy and maintaining an aesthetic design.

Figure 2. Comparison of a simple and direct and complex and indirect symbol to indicate the presence of a restaurant.

Agents and avatars
Agents and avatars that look like the user can serve as effective ambient displays. For example, one of the first thing one does when observing a group photo is to look for one's face in the group. Our group has done some initial research on the use of agents that look like the user for providing assistance with computer tasks. So far, we have discovered the users follow advice from agents that look like themselves [5]. In the workshop, we hope to discuss and extend our initial findings in this area.

Speech and sound
Auditory attention differs significantly from visual information, and is currently underexploited as a form of ambient display. In a pilot study, we designed auditory notifications in the form of speech and sound that contained specific and generic information, and asked users to rate their effectiveness, attention demand, and likeability. We found that speech interfaces were generally found to be more informative and that sound interfaces were generally found to be better at capturing attention. While initial, our results have implications for the design of auditory ambient displays.

Effect: Evaluate the effects of monitoring and feedback
Our final task is to determine the effects of our monitoring and feedback system. Longitudinal studies of these ambient systems need to be conducted, in order to understand their effectiveness in changing behavior, and to understand how comprehension at the periphery might change after using such a system for an extended period of time.

CONCLUSION
In this paper, we presented the IMPACT system, and a five part framework for the development of contextually aware systems that provide the user with information about the self. We are interested in the design and long-term use of this information in the form of ambient displays. We have found that there is often a disconnect between a person's perceived and actual behavior, and we hypothesize that appropriately designed ambient displays can address this problem. To date, we have explored abstraction and symbols, agents and avatars, and speech and sound user interfaces as display modalities that can present appropriate amounts of information in a lightweight fashion without being too distracting. We hope to eventually provide useful guidelines for what types of design features create the most appropriate and actionable ambient displays for use in mobile contexts.

REFERENCES
1.Chewar, C.M., McCrickard, D.S., and Sutcliffe, A.G.

(2004). “Unpacking Critical Parameters for Interface Design: Evaluating Notification Systems with the IRC Framework.” Proceedings of DIS04. New York; ACM Press, 279-288.

2. Fogarty, J., Forlizzi, J., and Hudson, S.E. (2001). “Aesthetic Infromation Collages: Generating Decorative Displays the Contain Information.” *Proceedings of UIST01*, New York: ACM Press, 141-150.

3. Heiner, J.M., Hudson, S.E., and Tanaka, K. (1999). “The Information Percolator: Ambient Information Display in a Decorative Object.” *Proceedings of UIST99*, New York: ACM Press, 141-148.

4. Ishii, H. and Ullmer, B. (1997). “Tangible Bits: Towards Seamless Interfaces Between People, Bits, and Atoms.” *Proceedings of CHI97*, New York: ACM Press, 234-241.

5. Li, I., Forlizzi, J., and Dey, A. (2007). “My Agent as Myself or Another: Effects on Credibility and Listening to Advice.” Submitted to DPPI07.

6. Mankoff, J., Dey, A., Hsieh, G., Keintz, J., Lederer, S., and Ames, M. (2003). “Heuristic Evaluation of Ambient Displays.” *Proceedings of CHI03*, New York: ACM Press, 169-176.

7. Weiser, M., and Brown, J.S. (1995). “Designing Calm Technology.” Available online at www.ubiq.com/weiser/calmtech/calmtech.htm.

8. Wisneski, C., Ishii, H., Dahley, A., Gorbet, M., Brave, S., Ullmer, B., and Yarin, P. (1998). “Ambient Displays: Turning Architectural Space Into an Interface between People and Digital Information.” *Proceedings of CoBuild98*. Darmstadt, Germany: Springer Press, 22-32.