ambientROOM: Integrating Ambient Media with Architectural Space

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ABSTRACT
We envision that the physical architectural space we inhabit will be a new form of interface between humans and digital information [2]. This paper and video present the design of the ambientROOM, an interface to information for processing in the background of awareness. This information is displayed through various subtle displays of light, sound, and movement. Physical objects are also employed as controls for these "ambient media."

Keywords
awareness, attention, periphery, ambient media, graspable media, physical interface, tangible interface, Tangible Bits

INTRODUCTION
Humans have highly sophisticated capacities for processing multiple information streams. While a particular source of information may occupy the "foreground" of our awareness, many additional sources may concurrently be monitored in the "background." For example, we may have a sense of the weather outside from ambient cues such as light, temperature, sound, and air flow from nearby windows. We may also have an idea of the activities of colleagues in the area from the ambient sound and the visible presence of passers-by.

Unfortunately, most computer interfaces fail to take advantage of our background processing capabilities. Graphical User Interfaces (GUI's) demand constant foreground visual attention, as multiple information streams compete for screen space. Likewise, keyboards and mice must be actively manipulated to be useful.

The ambientROOM is a personal interface environment designed to provide information for background processing. It displays information through subtle cues of sound, light, or motion easily relegated to the periphery of awareness [1]. Many of these "ambient media" displays are inspired by natural phenomena such as wind, sunlight, or the sounds of a rain forest. Research on awareness support in the CSCW field also stimulated this work [3]. In addition to those ambient media, the ambientROOM uses graspable objects such as bottles to provide control of the ambient media.

The video and the remainder of this paper describe the components of the ambientROOM and their initial applications. The paper also presents directions for further investigation. This work is a part of the larger project "Tangible Bits" which explores seamless interfaces between people, digital information, and physical space [2].

ambientROOM OVERVIEW
The ambientROOM was constructed from a Steelcase Corp. *Personal Harbor*™, a free-standing office room six feet wide and eight feet long. Several areas of the room are augmented with the interfaces illustrated below.

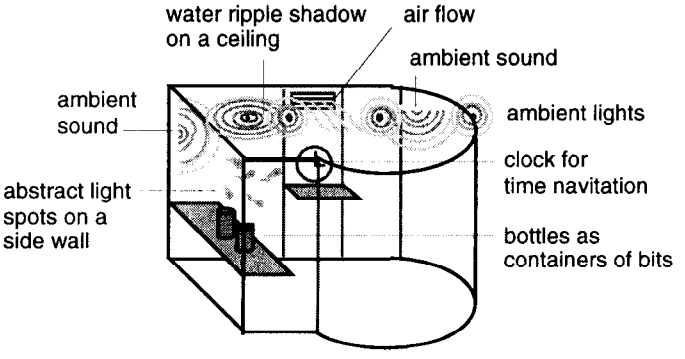

Figure 1: ambientROOM schematic diagram

AMBIENT MEDIA DISPLAYS
These particular ambient displays use light and sound to convey ambient information.

Water Ripples
One display allows the user to have some awareness of the activity of a distant loved one, for example, that of a child or spouse. For our first instance, we expressed the activity of a resident hamster in our laboratory, for which cage temperature, light level, and wheel motion had already been instrumented and displayed on a web page.

Initially, a small, motorized "phicon" (physical icon) was configured to vibrate as the hamster's wheel rotated. This type of display proved somewhat intrusive, so a mechanism

for altering the display mapping was implemented. Now, the hamster phicon can be grasped by the user and pointed at the ceiling of the room. This action "transfers" the vibration to the motion of a solenoid in a shallow water tank. A lamp reflecting off of the water then produces rippling shadows on the ceiling.

Light Patches

Another display also provides awareness of the physical presence of others. Electric field sensors are used to measure the amount of human movement in an atrium. This activity is represented by a pattern of illuminated patches projected onto an inner wall of the ambientROOM. This "active wallpaper" is rarely noticeable unless a sudden change occurs in the area's activity or the number of people present.

Natural Soundscapes

This display explores a multi-modal approach to ambient displays, including the communication of information through sound. The ambientROOM contains a subtle but audible soundtrack of birds and rainfall, whose sound volume and density are modulated in conjunction with variations in room lighting. Thus, approximate quantities can be monitored with this display- the number of unread email messages or the value of a stock portfolio, for instance.

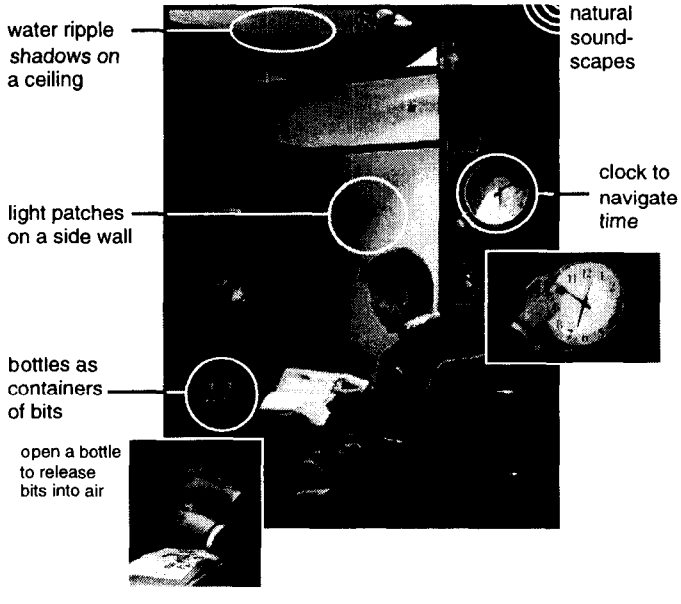

Figure 2: Ambient media displays and controls

GRASPABLE MEDIA CONTROLS

Faced with this number of information streams, a user might need a vehicle for managing ambient activity sources. Several such controls are employed in the ambientROOM.

Bottle

A small glass bottle is employed as a graspable "container" for digital content, such that uncorking the bottle "releases" information into the room. In this case, the load on the computer network was instantiated as the sound of vehicular traffic.

Clock

A second activity control, a large wall-mounted clock with exposed hands, allows navigation through temporal events. While traditional clocks serve only as displays of temporal information, the ambientROOM clock serves as a controller as well. Manual rotation of the clock's hands prompt the ambientROOM's displays to shift to their former or future states. Meanwhile, data including the *actual* time are projected onto the clock's face. Thus, a user returning from an absence could review the activity displays of past hours, or could peruse the displays of anticipated events.

DISCUSSION AND FUTURE WORK

The ambientROOM is an initial exploration of peripheral awareness of bits (digital information) in an augmented architectural space. Through the physical construction of various ambient displays, much was learned about the key factors to explore in future work.

One area for further exploration is the fuzzy boundary between the background and foreground of awareness. When a new process or activity catches our interest, it is often integrated smoothly into our foreground awareness. Designing interfaces that allow these seamless transitions is a challenging research opportunity.

Other future research areas include the variation between visual, auditory, and multi-sensory displays, the customization of interfaces for different users, and the development of guidelines for mapping information to ambient media. By employing current psychological research and experimenting with the ambientROOM, we hope to develop a set of design principles for ambient media, and to lay the foundation of augmented architectural space design as an interface between people and cyberspace.

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