Building Flexible Displays for Awareness and Interaction

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ABSTRACT
This video illustrates a set of flexible ambient devices that can be connected to any suitable information source and that provide a simple means for people to move from awareness into interaction.

Keywords
Ambient displays, information appliances.

1. INTRODUCTION
Ambient information displays are now a well-known concept in ubiquitous computing [3]. Yet most (but not all) of the example ambient devices seen so far are fairly limited. First, while all display some kind of information, many do not provide a way for a person to smoothly move from awareness of the information into interaction with it. Instead, people typically go to another source (e.g., a computer) for more detail or to work with the information. Second, most devices are rigidly tied to a single information source. This lack of adaptability limits how devices are used in particular contexts (e.g., different functions in the home or the office), and how they can meet the shifting desires of people over time. As an appliance, these devices could be much more opportunistic, where they can be repurposed to different people or contexts with only modest programming.

We designed these *flexible ambient devices* to address these issues by meeting two design goals.

1. The display should allow a person to smoothly move from awareness into interaction. Through a simple act on the device, such as a gesture or touch, the person should be able to gather more detail about that information as well as the means to take action on it. That is, devices should become a doorway into information access and interaction.
2. The display should be flexible, where it allows people to attach different information and interaction sources to it. The flexibility will allow a device to be customized to the needs or desires of a specific person or location. This is especially useful in a home setting, where the device may be handed down to different home members over time, or where it may be placed in different locations and contexts.

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2. DESCRIPTION
We have built three prototype physical displays to illustrate the concept of flexible ambient devices. All were constructed using Phidgets [1], a toolkit for rapidly prototyping groupware. Each device and how it displays information is described below.

1. *Glow Lamp* is a lamp with a shade that rotates to display five different colored panels, where colors range from warmer to cooler colors (fig. 1a).
2. *Ambient Garden* is group of eight flowers "growing" out of a small felt base. Each flower contains either a red or a green LED. The lights can be lit individually or as part of a group (fig. 1b).
3. *Ambient Beads* is a set of two beads that hang off the edge of a computer monitor. The beads can be moved up and down the monitor independently (fig. 1c).

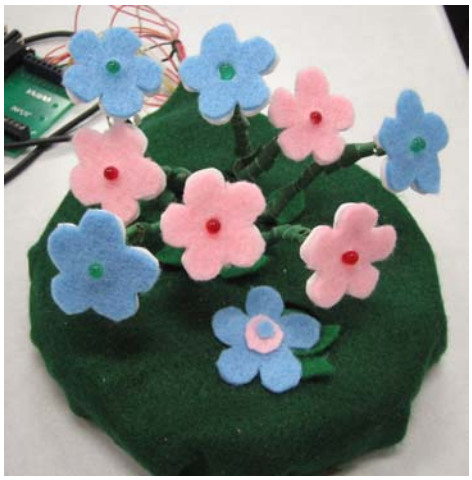
To move smoothly into interaction, each device also incorporates one or more touch or light sensors. These sensors allow the user to request more information through the simple gesture of touching the display, rather than having to go to another source (e.g., a computer). This is intended to provide a more direct and natural means of interacting with the information.

In addition, the ability to interact directly with the display device can lead to devices that are somewhat aware. For example, the ambient beads could represent two of my instant messaging contacts. The height of the beads could represent that the contacts are online, and touching the sensor for one of the beads (hence, one of the contacts) could open an instant messaging window. When the height shows they are offline, the same gesture could open a new email message instead.

The look of all three devices is visually and interactively designed to allow for a fairly generic information display. Varying colors, lights and levels are used to display both discrete ordered and unordered states, as well as continuous values. For example, the rotating lamp shade can display five discrete states (e.g., IM contact status, availability of a shared resource) through its five different colors. It can also display a value within a continuous range (e.g., a temperature forecast, hits to a web site, unread emails, activity level in a shared coffee room) through how far around the shade rotates. Since most ambient displays show abstractions of data [3], it is a logical step to design for a more generic abstraction while maintaining the inherent qualities of ambient displays.

3. FLEXIBLE DISPLAYS
The displays' flexibility is provided by a straightforward API that represents the style of data to be displayed. From the developer's

Figure 1a: the Glow Lamp



1b: the Ambient Garden

1c: the Ambient Beads

point of view, each device is wrapped up as a component, so that no knowledge of the motor, sensor or light setup is needed.

Connecting an information source is as simple as obtaining data values and passing them along to the device. Many information sources are readily available, for example through web services and programming APIs. All the programmer does is set the desired properties on the device and it will react appropriately.

For example, the Glow Lamp has four properties that are used to display information. If the information uses discrete states (e.g., IM contact availability) the programmer can simply associate each state with one of the five colored panels. As the information changes, the programmer needs only to update the *Lamp.Color* property.

If the information is a series of continuous values (e.g., a temperature forecast), the programmer initially sets a maximum and minimum value. Then whenever the information source updates, the programmer simply sets *Lamp.Curr_Val* to the new value, and the shade rotates to the correct position.

The other two prototype devices have very similar properties, and are just as easy to set up and use.

Events are provided by the devices to notify the programmer of sensor touches. These events are easily handled exactly as a typical widget event would be (for example, a button click). The programmer only has to write the callback that takes the appropriate action.

Each device also has a corresponding graphical "skin" or user control (fig. 2). These user controls can be connected to the physical device through the component. The skins will then reflect the state of the device without any code. This provides for an optional graphical view, in case the physical device is broken, located at a distance, or not present. The programmer can, if desired, write one or more new skins that represents various specialized uses of that device.

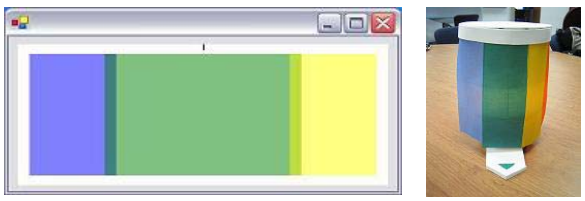


Figure 2: The basic graphical skin for the Glow Lamp

4. FUTURE WORK

These devices are intended as a first step towards creating ambient displays that are truly flexible. While we feel that these prototypes are successful, we recognize that several major improvements need to be made before the devices can be used to fully capitalize on the opportunities made possible by flexible, interactive information display. For example, if a device was wireless and self-powered, it could be repurposed by moving and placing it to a new contextual setting. If the device was location-aware, then moving it to this new setting could also connect it to a new information source.

Perhaps the most challenging needed improvement is that non-programmers should be able to connect different information sources to them. This difficult problem could be trivialized if information providers followed a standard, where the standard specified the information format in a way that made it easy for the devices to hook into it. The end user would just have to connect that device to the information source, and the software would then hook the two together. This connection interface needs to be very simple and familiar e.g., through drag and drop, through URLs, and so on.

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5. REFERENCES

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