

Ambient Displays Beyond Conventions

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Introduction

The notion of what constitutes a computer display is increasingly changing. No longer is a display confined to the typical CRT monitor with a single user, paying focused attention while interacting with virtual objects on the screen. Rather, computer displays are found in such diverse forms such as small screens in mobile phones and handheld computers to video projectors enabling a shared view among large audiences.

However, perhaps the most interesting development of displays is not primarily technical but conceptual. In 1988, Mark Weiser coined the term ubiquitous computing, denoting a kind of computing that departs from the view of human computer interaction as matter between an individual and a computer. Rather, as Weiser envisioned, human-computer interaction needs not to be confined to an interaction demanding the users full attention. On the contrary, Weiser sought for a disappearance of computers in the sense of moving them off to the background, the environment of human experience:

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it. (Weiser, 1991, p. 66)

Associated to this paradigm is the notion of *ambient displays*, that is, displays that unobtrusively convey information to users, without requiring the users' full attention.

In this paper we wish to articulate what we appreciate as core research issues when it comes to designing for attention. As such, this paper is best described as a position paper suggesting an agenda for an increased understanding concerning ambient displays and attention. The paper starts out with a section defining and describing the notion of ambient displays, together with representative examples of such technology. We then open up for a more general discussion around the meaning of ambient displays in relation to issues of how we as humans are very good at making use of peripheral cues in our everyday, unmediated experience. In this section we also outlines an agenda for future research when comes to designing for attention. In the following section we then introduce the "One pixel display", a prototype ambient display designed according to our suggested agenda before concluding the paper.

Ambient displays calling for attention

As the term *ambient* suggests, ambient displays are, unlike ordinary computer displays, a class of displays that does not call for its users' undivided attention. Rather, it is a kind of display that alongside furniture and other fixtures serves its role by constituting a part of the user's background environment.

Wisneski *et al* (1998) describes ambient displays as a technology that goes beyond the traditional graphical user interface:

Ambient displays takes a broader view of display than the conventional GUI, making use of the entire physical environment as an interface to digital information. Instead of various information sources competing against each other for a relatively small amount of real estate on the screen, information is moved off the screen into the physical environment, manifesting itself as subtle changes in form, movement, sound, color, smell, temperature, or light. (Wisneski *et al*, 1998)

However, moving information off the screen is not just a matter of extending the notion of what should be considered as a display. Ambient displays imply a different kind of use with a different kind of attention on part of the user. Whereas traditional use of computer displays typically requires the user's full attention, ambient displays capitalizes on different perceptual mechanisms:

An ambient display normally communicates on the periphery of human perception, requiring minimal attention and cognitive load. [...] (Mankoff *et al*, 2003)

As such, ambient displays cater to a different kind of utility than traditional task oriented computer use. Rather than requiring the user's, undivided attention, an ambient display is supposed to unobtrusively call for the user's attention when needed.

There are many possible use contexts for ambient displays and most current displays can be described as falling in the category of awareness applications. Wisneski *et al* (1998) suggests that ambient displays are apt at keeping users aware of what other people are doing and the state of large systems (for instance, weather, stock market, computer networks, etc).

Examples of ambient displays include the ambientROOM as described by Wisneski *et al* (1998). The ambientROOM is not one single display but rather an environment in form of a cubicle-like office fitted with a number of ambient displays of different modalities. One display of the ambientROOM monitors the activity of a hamster as it spins a wheel inside the cage. The activity of the mouse is mapped to the motion of a solenoid that, in turn, causes an actual water surface to ripple. The ripples are projected to the ceiling of the ambientROOM. This display later evolved to what Dahley *et al* (1998) refers to as the *Water Lamp* which is a more general device (not specifically targeted) at hamster activities). The water lamp allows digital information in general to be expressed as projected water ripples.

Yet another example of a display evolved from the ambientROOM project is the *Pinwheels* displays. The intention of this display is to visualize information flows in architectural space. Basically, the abstract flow of information is mapped to a concrete representation in the form of motorized pinwheels that spin at variable speeds.

These examples are research prototypes used to explore the design space of ambient displays. There are also examples of ambient displays that have made its way from the research laboratories to the marketplace. The company Ambient Devices offers a number of different displays, including what they refer to as The Ambient Orb. The Orb is a translucent sphere that dynamically changes color as the Dow Jones index fluctuates.

What is the meaning of ambient displays?

The examples presented in the previous section represent what we consider to be interesting ambient displays, both conceptually and technically. However, in spite of the sophistication of the research on this kind of technology, current research on ambient displays do not address what we take to be a core issue in relation to attention: what is the meaning of ambient displays?; or putted in other words: On what kind of foundation

should design of ambient displays be based as to avoid that the representation chosen is not completely arbitrary in relation to what it is intended to “ambiently” displayed?

This very general question can be broken down into a number of related questions. Is it at all possible to talk about the meaning of ambient display expressions or does the meaning reside external to the expression per se? if so, is the content that people experience from ambient displays internal and private to the user?

These questions are not specific to the design of ambient displays. On the contrary, they represent longstanding issues of practical and philosophical relevance and we have no intention, or ambition to settle these issues. However, the fact that the design of ambient displays run into and concretizes elusive problems related to the meaning of expressions in general does not necessarily imply that one should stay away from the difficulties of searching for a stable foundation for meaning. In the following we will outline what we take to be an interesting and important research direction that will guide our future research on ambient displays and attention.

A suggested agenda – Designing beyond arbitrary conventions

A motivation for ambient displays for visualization of abstract information is that human’s are very good at making use of peripheral cues in their everyday, unmediated experience. The use of ambient displays can be understood as reflecting an ambition to capitalize on this competence. However, there is an important difference between the unmediated, use of “real” peripheral cues and the artificial, virtual kind of peripheral cues as manifested in ambient displays. Largely this difference is a difference concerning the mapping between the expression and the content or meaning of the expression.

Consider the sound of the wind as it blows through the trees a windy day. The sound is not the wind, but rather a necessary, material consequence of the wind. This sound could be considered as a natural ambient display, informing people about some of the wind’s characteristics. For a slightly different example, consider the sound emanating, as a door is being violently slammed shut by an angry person. Apart from being a door that separates physical space, the door may also be understood as an “ambient display” that may serve the purpose to inform people in the vicinity about the mood of people closing the door.

In comparison and contrast, abstract information qualities as typically made concrete through ambient displays do not have any inherent form, no inherent perceivable qualities. Any design of an ambient display involves a decision on part of the designer concerning the form that she must give the representation of the information in question. We take it to be an important question if this part of the design process can be supported. Is it possible to ground such decisions on some kind of general foundation? Is each design situation so unique that any general theory would be of little or no help?

On the one hand, the design of ambient displays could (and some seem to be) based on what we refer to as *arbitrary conventions*. The designer postulates a convention concerning how a particular expression relates to a piece of information without there being an existing, established connection between the expression and that which is intended to be expressed. This seems to be the case with the Water ripple display mentioned previously.

This kind of approach demands an explanation of what an expression signifies. This may very well be possible under some circumstances. However, in order for ambient displays to be more self-contained with respect to their meaning, a different approach is necessary. What such an approach could be is an open issue, but we suggest that plausibly it requires a foundation, a theoretical basis that could inform the design in such a way that the expressions of ambient displays are intersubjectively accessible to potential users.

Our suggested research agenda is therefore to reduce the technical complexities of ambient displays to a bare minimum in order to shift focus from the intricacies of electronics and mechanics to the underlying conceptual issues concerning non-arbitrary expressions of abstract information.

The One Pixel Display – Towards design for attention beyond arbitrary conventions

In order to explore design of ambient displays beyond arbitrary conventions we take it to be important to keep the technology as simple as possible. So, although it is quite easy to see how various kinds of features or functionality could be added to this one pixel display as presented below we instead wanted to avoid that and keep the design really simple as to highlight the important question of how to represent something without having to rely on cultural or social conventions or representing a piece of information by simply choosing any arbitrary form.

The One Pixel display consists of a bright light emitting diode connected to a small micro-controller that communicates serially with a computer. The brightness of the diode can then be set from the stationary computer to show different kinds of light patterns (e.g. bright fast flashes or calm changes of the brightness like a light dimmer). Figure 1 shows a picture of the One Pixel Display. Here, we have putted the display in a pot and covered it with half transparent small stones as to make the technology itself visually disappear.



Figure 1. The One Pixel Display

Since the One Pixel Display has a universal interface like any other kind of computer display it can be used to visualize all various kinds of status changes in the periphery of the users attention. It could for instance be used to indicate changes in the stock market, indicate weather changes like a barometer, or be used to unobtrusively notify its user about incoming email and whether the priority of the email received is set to normal or highest.

Now, if we take the case of email as an example of how the One Pixel display can be used, we can think of a constant stream of e-mails; a mixed bag of spam, private and professional emails, more or less important or urgent mail. Allegedly, an ambient display like the One Pixel Display can help a user maintain some amount of awareness about this stream of mails without the need to pay full attention to the email application as such. Rather, the display, if well designed, unobtrusively communicates some aspects of the information while the user can attend to things and activities other than email. If for instance an email is received that is sent by someone in the users contact list it could be announce by a very bright light from the One Pixel display. On the other hand, if just another spam arrives it could be visualized with only one really weak light. In this way the announcing of an incoming really important email could be designing in the same fashion as e.g. the sirens on an ambulance are designed to call for our attention beyond any arbitrary convention. And similarly, the announcement of an incoming unimportant email (e.g. a spam mail) could be announced as unobtrusively as a clock announces each second of an hour by just moving its arrows one small step for each second that passes.

Conclusions

In this paper we have taken a departure in the current trends towards ubiquitous computing and ambient displays in our efforts to design for attention in an unobtrusive, and for us as human beings, natural way. In our efforts made we have thus tried to highlight one of the core questions related to design of ambient displays which has to do with how to chosen an appropriate representation that is not conventionally bounded on a social or cultural level, nor just arbitrary chosen. Instead, we have made a first attempt to outline an agenda for research into design of ambient displays, highlighted a couple of interesting research question in relation to this agenda and illustrated how our ideas can be concretizes by introducing the One Pixel Display project. The next step in our research will be to carry out some user studies and do some experiments on how the One Pixel Display should be configured as to provide its user with relevant “background” information without calling for its users full attention.

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References

Dahley, A., Wisneski, C., & Ishii, H. (1998). Water Lamp and Pinwheels: Ambient Projection of Digital Information into Architectural Space, Proceedings of ACM CHI 98 Conference on Human Factors in Computing Systems (Summary) (Vol. 2, pp. 269-270).

Ishii, H., Wisneski, C., Brave, S., Dahley, A., Gorbet, M., Ullmer, B., & Yarin, P. (1998). ambientROOM: Integrating Ambient Media with Architectural Space, Proceedings of ACM CHI 98 Conference on Human Factors in Computing Systems (Summary) (Vol. 2, pp. 173-174).

Weiser, M. (1991). The Computer for the 21st Century. *Scientific American*, vol. 265, no. 3, Sept. 1991, pp. 66-75.

Wisneski, C., Ishii, H., Dahley, A., Gorbet, M., Brave, S., Ullmer, B., & Yarin, P. (1998). Ambient Displays: Turning Architectural Space into an Interface between people and Digital Information. In N. Streitz (Ed.), Proceedings of the International Workshop on Coperatibe Buildings (CoBuild'98). Darmstadt, Germany: Springer.