The Dark Patterns of Proxemic Sensing

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To be accepted and trusted by the public, proxemic sensing systems must respect people's conception of physical space, make it easy to opt in or out, and benefit users as well as advertisers and other vendors.

In the mid-1960s, anthropologist Edward T. Hall theorized that people correlate social distance to physical distance.[1] As Figure 1a shows, social intimacy between individuals increases as the distance between them decreases. The degree of social interaction can be divided into four proxemic zones, with each zone's actual area mediated by physical factors such as orientation and body language as well as cultural expectations.

Researchers recently applied Hall's proxemics theory to the design of ubiquitous computing (ubicomp) ecologies.[2] Just as people expect increasing social engagement as they approach each other, so should they naturally expect increasing *proxemic interaction* possibilities as they get closer to devices and devices get closer to each other.

From a technical perspective, ubicomp systems determine proxemic relationships by continuously tracking the location and orientation of people, the devices they carry (for example, tablets and smartphones), and other surrounding devices (for example, large horizontal and vertical displays) within the ubicomp ecology, as Figure 1b shows. Researchers then exploit this knowledge to create various proof-of-concept interfaces. Examples of proxemic sensing systems include ambient displays that change their content as people approach them, techniques that facilitate information transfer between nearby devices, and interactive gaming technologies such as Microsoft Kinect.[2,3]

While ubicomp systems are designed to improve peoples' lives, they can sometimes be subverted to create bad user experiences or even violate social mores. Thus it behooves designers to consider the negative as well as the positive effects of these technologies. One way to do this is by identifying *dark patterns* in proxemic interactions.

DARK PATTERNS

Independent user experience consultant Harry Brignull defines a dark pattern as "a type of user interface that appears to have been carefully crafted to trick users into doing things [and that does] not have the

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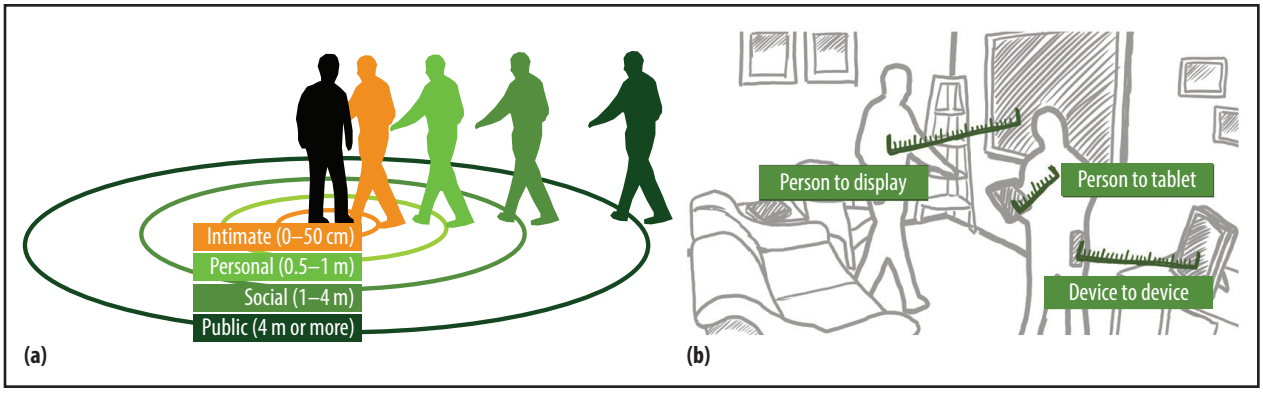

Figure 1. Researchers have applied (a) Edward Hall's proxemics theory, which correlates the level of social intimacy to physical distance, to (b) the design of ubiquitous computing ecologies, in which proxemic interaction between people and devices and between devices and other devices likewise correlates to physical distance.

user's interests in mind" (http://darkpatterns.org). After examining various types of proxemic sensing systems including existing products, research prototypes, and envisaged future systems, we identified eight different dark patterns:[4]

- *Captive audience.* A person enters a particular area to pursue an activity that takes a given time and that doesn't involve the system. The system senses the person at that location, and begins an unsolicited (and potentially undesired) action based on the fact that the person is now captive.
- *Attention grabber.* A person passes by a strategically located system's field of view. The system takes deliberate action to attract and keep that person's attention.
- *Bait and switch.* The system baits a nearby viewer with something that from the viewer's perspective is desirable, but then switches to something else after the person approaches the system and/or directs his or her attention to it.
- *Making personal information public.* As a person enters a particular area, the system makes his or her personal information publicly visible.
- *We never forget.* In day-to-day life, proximity is ephemeral—the proxemic relationship between engaging parties dissolves as soon as they separate. In contrast, systems can tag any proxemic interactions as indicating a persistent (and perhaps undesired) relationship that is never forgotten.
- *Disguised data collection.* Information gathered by a system to provide a certain service is abused to build rich profiles about users without their consent.
- *Unintended relationships.* The system tracks an individual's proxemic (and perhaps unintended) relations with others and constructs a social network on the assumption that those people are somehow socially related to the individual, when in fact there's no such relationship.
- *Milk factor.* The system forces a person to move through or go to a specific location to get the service it provides.

These dark patterns can be used to analyze systems to recognize existing and potential abuses. Consider, for example, a scene from the dystopian film *Minority Report*. As protagonist John Anderton walks through a public corridor, various displays recognize his passage and exploit his presence (captive audience). They each call out his name (attention grabber) and display details about him (making personal information public). The systems then transmit his location and identity to a central database (disguised data collection), where other systems use it for surveillance purposes.

Unfortunately, such abuses aren't limited to science fiction, as various real products already do similar things.[4]

Figure 2a illustrates Novo Ad's advertising display (www.novoad.com), which appears to be a standard mirror like that found in a public bathroom. An approaching person triggers the system to display a full-screen video advertisement, including sound, which eventually shrinks to quarter-screen size as that person uses the mirror (captive audience, attention grabber). The system also tracks the number of views (disguised data collection).

Figure 2b is a sketch of the Cheil Worldwide ad agency's use of the Nikon D700 Billboard for targeted advertising in a busy subway station in Seoul, South Korea, where it displays life-sized images of paparazzi. When the system detects passersby via motion sensors, it flashes lights to simulate camera flash bulbs going off and plays

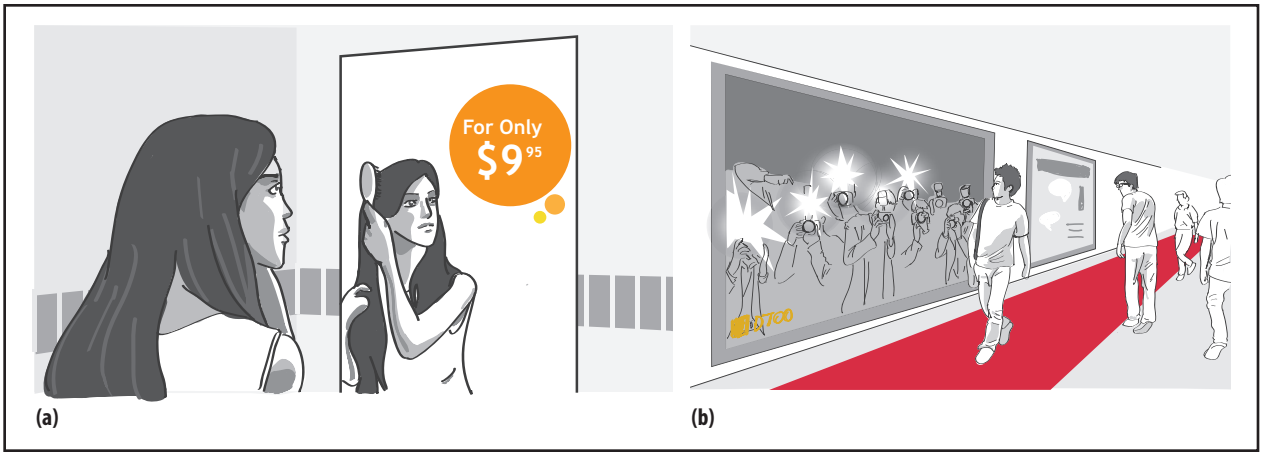

Figure 2. Examples of dark patterns in existing proxemic sensing systems. (a) Novo Ad display that doubles as a mirror and medium for video advertisements (captive audience, attention grabber, disguised data collection). (b) Cheil Worldwide Nikon D700 Billboard that displays life-size images of paparazzi and, upon detecting passersby via motion sensors, flashes lights to simulate camera bulbs going off and plays audio of a crowd cheering (captive audience, attention grabber). Sketches by David Ledo.

audio of a crowd cheering (attention grabber, captive audience).

Another example is a drink vending machine that requires people to come close to use it (milk factor) and—unbeknown to users—applies face recognition technology to collect user demographic information (disguised data collection).

Dark patterns can also serve as a starting point for identifying root problems of such technologies by considering what they have in common. Two examples are the opt-in/opt-out problem and conflicting notions of spatial ownership.

OPTING IN/OPTING OUT

A core problem of many proxemic sensing systems is that they assume that users opt in simply by entering the tracked space and then opt out by leaving the area. However, opting out might not always be reasonable or possible (captive audience), or the damage could already be done (attention grabber). Even if people can leave the space quickly, they will be uncertain about whether or not their proxemic data has been stored (we never forget).

The dilemma is that proxemic interactions, like social interactions, are often unintentional. While people use cues to distinguish deliberate from incidental contact, ubicomp systems tend to simplistically interpret all actions as a desire to interact, which is similar to the Midas touch problem associated with touch-based interfaces.[5] This can be mitigated by clearly communicating the implicit opt-in zones around proxemic sensing systems and by making opt-out easy—for example, through explicit gestures or turning off certain services on mobile devices. At the same time, these safeguards also could inhibit engagement with the system and thereby defeat its purpose.

SPATIAL OWNERSHIP

People have a nuanced sense of spatial ownership. For example, when you sit on a public bench, it temporarily becomes your private space, even though you don't legally own the bench. Passersby respect this temporary ownership by choosing a different bench, sitting at its opposite end, or asking you permission to sit down.

In contrast, proxemic sensing systems often have a totalitarian view of spatial ownership rather than one in which space is shared. Those who walk in front of a proxemic sensing display but have no interest in the content won't appreciate the system calling out to them (attention grabber) or collecting data about them without their consent (disguised data collection).

Unfortunately, this view of spatial ownership is common in advertising, and we can expect it to only get worse as sensing and display technologies improve. While legislation can protect people's privacy in public spaces, stakeholders might withdraw if regulations are overly burdensome, thus removing the potential benefit of proxemic interactions.

EXAMPLE SUCCESSFUL DESIGNS

At the very least, a proxemic sensing system must make its territorial boundaries clear to passersby. However, the best solution is to design systems that consider the interaction context, give people a choice, and are mutually beneficial.

For example, consider the Proxemic Peddler, a prototype advertising display designed to attract pedestrians and keep their attention. The original implementation was obnoxious, aggressively calling out to people and berating them when

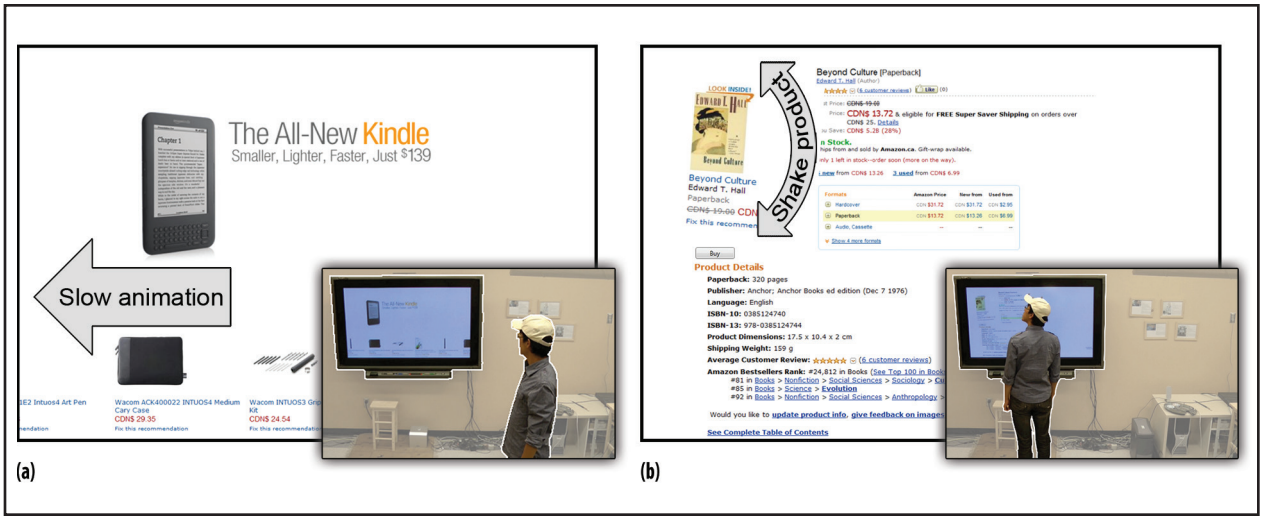

Figure 3. Proxemic Peddler prototype advertising display. (a) The system uses rapid animation of a featured product to attract a passerby's attention, then slows the animation to a readable speed if someone approaches. (b) If the person looks away, the system tries to re-attract his or her attention with a slight shaking animation of the product.

they left. The developers successfully redesigned the system to more subtly capture the interest of passersby. As Figure 3a shows, initially rapid animation of a featured product slows down to a readable speed when a person approaches to examine the ad. If the person looks away, the system displays a slight shaking animation of the product, as shown in Figure 3b, as well as alternate potentially appealing products. However, it doesn't persist in this action: the system recognizes when it has lost a person's interest and ceases attempting to re-attract the individual. As with most well-crafted ads, the viewer as well as the advertiser benefits—in this case, the person can quickly see and explore products of interest and move on if there are none.[6]

Another good example is a novel hands-free "washroom gaming system" developed by UK-based Captive Media (www.captive-media.co.uk/product-overview). The system consists of a high-definition display installed at eye level above urinals that normally plays a mixture of ads but, when a user approaches, flips into gaming mode. By "aiming" left or right, the user can control, for example, the direction of a soccer ball in a goal-kicking game or a car in a racing game.

Although the system exploits the fact that "the average 'visit' time for a British male is 55 seconds," it satisfies its captive audience by making an otherwise boring activity fun. In fact, Captive Media attributes the system's growing popularity to an entertainment-first design that is 90 percent game play and only 10 percent advertising. The system is connected to the Internet and keeps track of all players' scores from more than 100 installations around the world, encouraging users to compete with others and even win prizes. At the same time, the company recognizes that the system isn't appropriate for all public urinals; the most common venues are bars and other social areas where the system can serve as an icebreaker. Captive Media also recognizes that customers should have an opt-out choice, and recommends that not all urinals in a washroom be equipped with the technology. It likewise monitors social media to ensure that consumer responses are positive.

Another example of a successful proxemics sensing system is the aforementioned Nikon D700 Billboard developed by Cheil Worldwide. This system engages in relatively aggressive advertising by using flashing lights and crowd cheering sounds to grab the attention of passersby, who are guided to a store that sells that particular camera by the red carpet in front of the display. However, the system does so in a humorous and engaging way. Moreover, it doesn't target a single person but multiple users simultaneously in an anonymous fashion. Finally, people can easily opt out of the situation by moving on—they aren't forced to stop and view the display or enter the store.

These positive examples of proxemic sensing point to the technology's great potential, but research is still in the early stages. Delicately balancing implicit and explicit interaction remains a problem: while implicitness is highly desirable for usability, it could also cause annoyance and frustration; at the same time,

if proxemic interactions become too explicit, they will become burdensome, thereby defeating the system's purpose. In short, proxemic sensing systems must respect people's conception of physical space and make it easy for users to opt in or out. In addition, while advertisers and other vendors will naturally seek to exploit dark patterns for their own purposes, users must also benefit if they're ultimately going to accept and trust these systems.

Acknowledgments

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