Proactive Displays: Supporting Awareness in Fluid Social Environments

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Academic conferences provide a social space for people to present their work and interact with one another. However, opportunities for interaction are unevenly distributed among the attendees. We seek to extend the opportunities for interaction among attendees by using technology to enable them to reveal information about their background and interests in different settings. We evaluate a suite of applications that augment three physical social spaces at an academic conference. The applications were designed to augment formal conference paper sessions and informal breaks. A mixture of qualitative observation and survey response data are used to frame the impacts from both individual and group perspectives. Respondents reported on their interactions and serendipitous findings of shared interests with other attendees. However, some respondents also identify distracting aspects of the augmentation. Our discussion relates these results to existing theory of group behavior in public places and how these social space augmentations relate to awareness as well as the problem of shared interaction models.

Categories and Subject Descriptors: H.5.2 [**Information Interfaces and Presentation**]: User Interfaces—*Interaction styles (e.g., commands, menus, forms, direct manipulation)*; H.5.3

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1. INTRODUCTION

Settings where small groups form and reform as people engage in sociable activity for the purpose of interacting and networking with each other are often fluid. This fluidity is marked by shifting and changing social groupings that range from serendipitous encounters to planned meetings as participants work to identify individuals with whom they want to interact. Receptions, professional meetings, and conferences are examples of fluid social situations, but there is a wide range of social settings with varying degrees of social fluidity.

An academic conference is one example of a fluid social setting where people gather for different purposes and move through a range of social engagements. Giving formal and informal research presentations, listening to presentations, asking questions, and casual conversations are just a few of the common activities. By attending even a small number of conferences, one can identify several common social practices, perhaps norms, which occur during a conference. Many of these social practices exist to facilitate an active "give and take" and exchange of ideas, which may result in new research directions, new collaborations, or new friends and acquaintances.

Academic conferences are almost always augmented in some way to enhance the possibilities of active give and take. The practice of issuing name badges to conference attendees and requiring that the badge be worn (somewhere, somehow) is a type of augmentation to the conference social space. In some settings, the use of color or other badge adornments (e.g., stickers or streamers) is used to indicate special status or permissions at a glance. For some attendees the use of badges is more common than others. While few academics wear name badges on a daily basis, the practice of wearing identification, including name and photo, is relatively common in industry and a requirement in much of government and the military.

Low-tech augmentations, such as badges, event signage, and printed conference programs are designed to achieve several goals. Returning to our example of a conference badge, the badge may include the wearer's name, affiliation and/or other information, allowing other attendees to easily identify the wearer, aiding in making new acquaintances and renewing old ones. A badge may act as a "proof of purchase," differentiating attendees from individuals who might be sharing the same physical space of a large conference venue. For some attendees, the badge and related adornments provide a way to note inclusion or differentiation from the other attendees.

Many people associate the concept of "networking" to the social practices and activities at a conference. The structural analysis of the relations and the development of those relations is one possible use of Social Network Analysis (SNA) [Berkowitz 1982; Wasserman and Faust 1994]. A range of systems have been implemented that use Social Networks as a mechanism to support relation discovery and to facilitate online interaction through email or other forms of electronic communication [Kautz et al. 1997; Contractor and Bishop 2000; Ogata et al. 2001; Nardi, et al. 2002; McDonald 2003]. Still other systems have been specifically designed to leverage an existing setting and existing relations to bridge online and offline communication [McDonald and Ackerman 2000; McDonald 2003]. Formal notions of SNA do not motivate the approach we take in the following work. That is, we do not seek to explicitly articulate known social networks, nor have the users explicitly state who they know or do not know. Instead, we focus on the more qualitative aspects of social involvement in a fluid dynamic social space, like that of an academic conference.

Our research is motivated by the desire to further augment fluid social settings, like those of a conference, to enhance the action and interaction of the participants. The deployment that we subsequently describe and evaluate involves more technology than is commonly used at current conferences. Our deployment uses a *proactive display;* a large display that can sense and respond to the physical presence of one or more people. Conference attendees create web-based profiles of their interests, associate these profiles with a physical token (a radio frequency identification (RFID) tag), and wear or carry the token. When attendees are near a proactive display, content from their profiles can be shown. This technology and the associated applications are described more fully below.

We had three primary goals for the design and deployment of these applications:

—Enhance the feeling of community among conference attendees.
—Mesh with common social practices at the conference.
—Manage the privacy concerns of all participants.

The focus of this article is the qualitative evaluation of a suite of proactive display applications deployed at an academic conference.

Prior research has focused on technical augmentation of conference social spaces. Some systems attempt to facilitate the one-on-one, "person finding" activities, while others create visualizations based on aggregate data. Most of these prior efforts have been technical explorations, with little in the way of systematic evaluation. This work is differentiated from the prior work along two dimensions; (a) our applications address individual to group relationships in a novel way and (b) we perform a detailed evaluation of the social impact of the applications in the conference setting.

The results of our evaluation can be used to elaborate Goffman's characterization of *focused* and *unfocused* interaction [Goffman 1963] and how people participate in fluid social spaces like conferences. These results are closely aligned with the first design goal of enhancing the feeling of community among the participants. However, our evaluation also resulted in some unexpected findings. For example, the technology incorporates an interaction model that confuses some people. As well, playful behaviors resulted in both positive comments about the resulting atmosphere [Boyd 2004], and some negative attribution about the system being broken.

The remainder of the article describes the deployment and evaluation of three proactive display applications at an academic conference. The overall design approach is described, including details of each application. We highlight the physical and social setting for each application. The evaluation methods are described in detail, including data collection and analysis. In our discussion, we frame the results relative to existing theory on group behavior in public spaces. But first, we describe some related work.

2. RELATED WORK

This research blends two streams of existing research in the augmentation of physical social spaces. One stream can be characterized as wearable or handheld technologies that attempt to facilitate interactions between people, between people and computers or between people and artifacts; the other focuses on the use of large displays in shared contexts.

Researchers using wearable or handheld technologies to augment physical social spaces have relied on a mix of technologies. The wearable approach has included a range of infrared (IR) and radio frequency (RF) devices that can be worn like a conference badge. Meme Tags [Borovoy et al. 1998] are small badges with LED displays that are intended to facilitate one-to-one interactions by showing information relating wearer to viewer. Meme Tags collect and aggregate information that participants can view, but they are not designed to facilitate small-group interaction (beyond one-to-one interactions). Intellibadge [Cox et al. 2003] used active RFID tags for tracking people throughout a conference. Large displays show graphical visualizations of aggregate information about all conference attendees. There is little in the way of evaluation regarding the social impact of the system on participants' conference experiences.

Other systems have utilized handheld computers or personal digital assistants (PDAs) as a basis for augmenting the physical social space. The SpotMe Conference Navigator (http://www.spotme.ch), is a conference matchmaker that runs on a PDA using RF to perform one-on-one profile matching. When another attendee with a similar profile is near, both users are notified. Unfortunately, there are no reported user studies of SpotMe. PDAs were also used by Sumi and Mase [2002] to suggest face-to-face interactions and to recommend interesting things to see at a conference or laboratory open house. The evaluations of these systems focused primarily on use of the system and system logs rather than the impact on users or the social space.

One notable example of an evaluation of social impacts was a system to encourage conversations among small groups during museum visits [Woodruff et al. 2001]. The evaluation of this system [Grinter et al. 2002] focused on user dyads (pairs) sharing a single device. The study noted the amount and type of one-on-one interaction that was promoted by the device as well as how it changed their interaction with others in the same physical space.

The proactive display applications that we designed and deployed are different from these systems. The prior systems focus either on dyadic relationships or aggregate features of the overall population. While we aim to facilitate one-to-one interactions, we also want to support the broader range of one-to-many and many-to-many interactions common in a conference setting.

Another thread of research uses large interactive displays situated in public or semi-public areas. Opinionizer [Brignull and Rodgers 2003] uses a large display to which people post opinions via a nearby keyboard. Observations and interviews from two deployments revealed the importance of carefully situating the displays and making interactions as lightweight as possible. The IM Here [Huang et al. 2004] system also identified the need for lightweight interaction by using a large public display as an instant messaging station. Dynamo [Brignull et al. 2004] used a large display and a media sharing station evaluated at a high school. A two week deployment of Dynamo indicated the value of "over the shoulder learning" in a group setting, and the need to support individual appropriation activities.

Two other large display systems focused on augmenting a conference environment. PlasmaPlace [Churchill et al. 2004] uses a large display to show conference-related content and to allow conference attendees to navigate through an on-line community. Another variation on large shared displays is AgentSalon [Sumi and Mase 2002]. The AgentSalon display shows interactions among animated characters representing nearby users. The characters act as proxies for their users, exchanging bits of user profile to discover shared interests.

All of these prior shared display applications require direct, explicit manipulation at or near the display, which may limit people's willingness to step up and participate [Rogers and Rodden 2003]. Our proactive display applications are designed to respond to people nearby without any need for them to explicitly interact with the displays or other devices connected to the displays.

Some display applications are beginning to augment the physical space in a more proactive way; by recognizing and responding to individuals who enter or leave the physical space. GroupCast [McCarthy et al. 2001] identifies individuals based on IR personnel badges and selects content to display based on user profiles. Villar et al. [2003] also created a system that enables displays to respond to people nearby based on wearable *pendles*, small wireless devices that can store information and detect gestures. Both of these systems were deployed in lab environments among people who already knew each other fairly well. The evaluation of these systems was largely based on anecdotal data.

Our systems and our deployment differ from the prior work in a number of ways. The applications that we deployed in our field trial use large, public displays that are not interactive but *proactive*. The displays detect people nearby, based on RFID tags that can be placed in their conference badges. The displays respond in contextually appropriate ways without requiring any direct manipulation or input from attendees, thus overcoming social awkwardness and enticement issues identified in prior studies. Our deployment was in a less restricted context, with a much larger number of people than most of the previous work. We attempt a comprehensive, systematic evaluation of our deployment and report our findings: both positive aspects and those that elaborate the grey areas of our design.

3. SOCIAL SETTINGS AND SYSTEMS

Our focus differs from the prior research in that we are interested in the one-to-many and many-to-many, in addition to one-to-one, relations that occur in groups. The technology, the physical environment, and the social setting, all need to be carefully considered in the application design and in situating our deployment.

There is an on-going discussion of "context" in CSCW and ubiquitous computing [Dourish 2004]. In the practical sense of deploying a technology to enhance the conference experience, we take the context to be a specific physical location at a conference and the social interactions that happen there. Different physical settings of a conference create rather distinct social affordances. A conference paper session affords different social behaviors from that of a coffee break. Interactions will have a different character based on the identity and number of people who are in the physical setting.

Although the applications were designed for different settings, they share a common technical infrastructure. The hardware infrastructure includes servers with network connections to client machines. The client machines manage large displays (either projection or plasma displays) and handle input from RFID tag readers. The content for the machines comes from a database of profiles that conference attendees create via a web-based interface, which includes information such as name, email address, affiliation, photo and various representations of interests. Each profile can then be associated with an RFID tag worn by the attendee, unobtrusively inserted into his or her conference badge.

Three applications were deployed at the conference AutoSpeakerID, Ticket2Talk and Neighborhood Window. The following descriptions highlight these applications, the physical settings, and the interactions that each application may naturally and beneficially support.

3.1 AutoSpeakerID

AutoSpeakerID (ASID) is an application that displays the name affiliation and photo (if provided) of a person asking a question during a question and answer period following a paper or panel presentation. In many conference sessions, the audience is given a chance to ask a presenter questions about their paper or presentation. A common practice is for a person asking a question to state their name and organizational affiliation before asking a question. This helps the speaker and audience better understand the context of the question and facilitates future follow-up with the questioner by the speaker or audience.

However, the practice of introducing oneself before asking a question is not always followed. Even in cases where this norm is enforced, questioners' names or affiliations may not be heard clearly by the audience. This is especially true

Fig. 1. AutoSpeakerID screenshot.

when the questioner is hurrying to ask her question. Even when the questioner's name and affiliation is heard, it may not be obvious how to spell them, for the purpose of online searching. These problems can be further exacerbated when the questioner's native language differs from that of many in the audience.

ASID is designed to visually augment the common practice of verbally stating name and affiliation. The microphone stand is augmented with an RFID antenna so that when a questioner approaches a microphone to ask a question, if she is wearing an RFID tag in her badge, a large display off to the side of the room shows the name, affiliation and a photo from that person's profile. Figure 1 shows a screenshot from the application and Figure 2 shows ASID with questioners lined up at the microphone and the ASID display behind them. The questioner's information is shown on the top half of the screen in order to increase visibility from across the room.

Without carefully considering the community norms, individual goals, and physical setting, a proactive display like ASID could be detrimental to the conduct of a conference session. For example, a questioner should have a right to refuse (i.e., a conference attendee might not state their name and affiliation for some reason). Additionally, the focus of a paper session or panel is often on specific content, the ASID should not detract significantly from the session's content and intellectual exchange.

These issues were among several that were specifically considered during the design and deployment of ASID. The ASID display was specifically smaller than

Fig. 2. AutoSpeakerID in a session.

the main presentation screens, and was positioned to the side of the general session space (see Figure 3). There were no technical controls over the information that was entered into the profile database. An individual could enter any name, affiliation and picture to represent herself. We therefore implemented a technical control over the output—a "kill switch" capability on the computer running the application—in case any profile with highly offensive content was shown. Although some liberties were taken with profile information (what we call "gaming", further discussed in our evaluation data), the kill feature was never used during the deployment.

3.2 Ticket2Talk

The second proactive display application designed and deployed is *Ticket2Talk* (T2T). This application shows explicitly specified content when people are near the display—providing, in effect, a "ticket to talk" [Sacks 1992]. T2T is designed for a more informal setting within the conference like a coffee break area or conference lounge. T2T and ASID share a common theme: they are designed to explore the one-to-many relationship building that fits in several conference settings.

The notion of a "ticket to talk" is important to the design of this application. In these settings, the visual ticket should be a representation of a topic about which a participant would be happy to talk with anyone while at the conference.

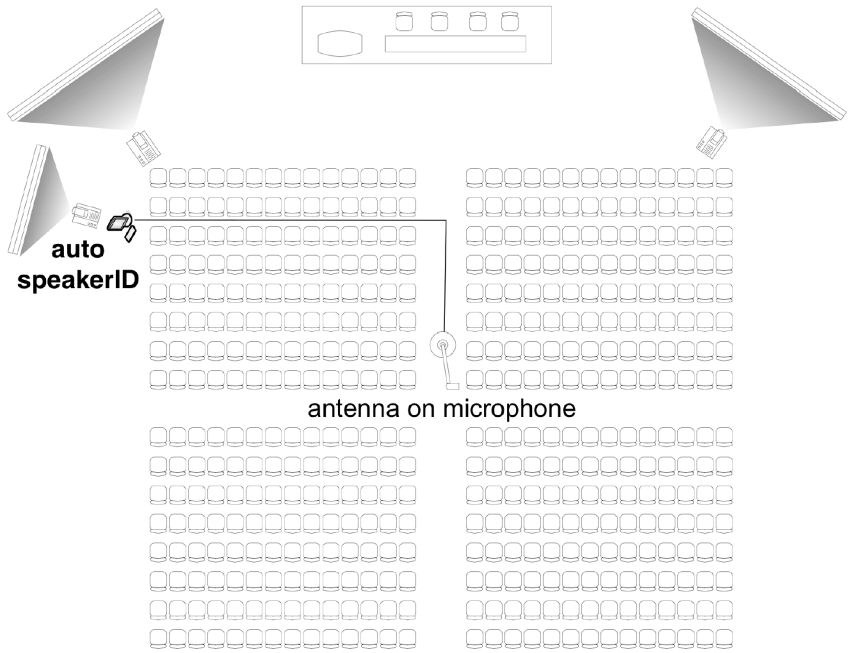

Fig. 3. AutoSpeakerID general session floor plan.

The user profile includes two special fields used by this application: a URL for an image and a caption for that image. A ticket to talk could represent a professional interest (e.g., a research project or the cover of a recently published book), or a personal interest (e.g., a picture of a favorite pet, vacation spot or piece of art).

Figure 4 shows two screenshots of T2T. The ticket to talk image is displayed center screen, with the picture, name and affiliation of the participant whose ticket it is at the top. An individual's ticket is only on the display for five seconds at a time. A portion of the screen near the bottom shows a collection of thumbnail pictures and names of other people whose RFID tags have been detected near the display. The thumbnails represent a queue of people who will soon have their tickets to talk shown on the display. Arrows appear on either end of the queue when there are more people detected in the area than can be shown in the list of thumbnails. After an RFID tag in the queue is not seen for 60 seconds, the profile associated with that tag is removed from the queue.

At the conference, T2T was deployed behind a table used to serve coffee and snacks during conference breaks. Figure 5 presents our deployment floor plan, with an indication of the antenna ranges and tag read area pattern. Figure 6 is a picture showing a small group standing in front of the display (approximately center of picture). The RFID antennas are the square beige panels mounted on microphone stands to the left and right of the group. The people in Figure 6, have gotten coffee and are talking in front of the T2T display.

The sequencing of "tickets" shown on the display was designed to reflect the serial nature of how attendees move through a line to get coffee. Naturally,

Fig. 4. Example Ticket2Talk screenshots.

this is not a perfect match, as people will sometimes jump in and out of line to quickly grab coffee or tea. But for a person who progresses through the line, the displayed "tickets" provide an opportunity to learn about others nearby.

T2T was designed to provide opportunities to initiate conversation. However, one clear trade-off is that not every participant will want to initiate new conversations at the moment they are near the proactive display. Thus, the application should ensure *plausible ignoreability*. That is, no one should feel compelled to initiate conversation with another attendee who just happens to be nearby. We situated the displays on the periphery—behind the tables with food and beverages—so that a person moving through the line can simply notice the stream of tickets, without acting on any particular one. The tickets on the display can contribute to increased awareness of other attendees; both their identities and something of their interests. This information may be used at some later time to initiate an interaction (e.g., at a demonstration or poster session, or the conference reception).

3.3 Neighborhood Window

The Neighborhood Window (NW) application shows a visualization of both the unique and shared interests of conference attendees near the display. NW

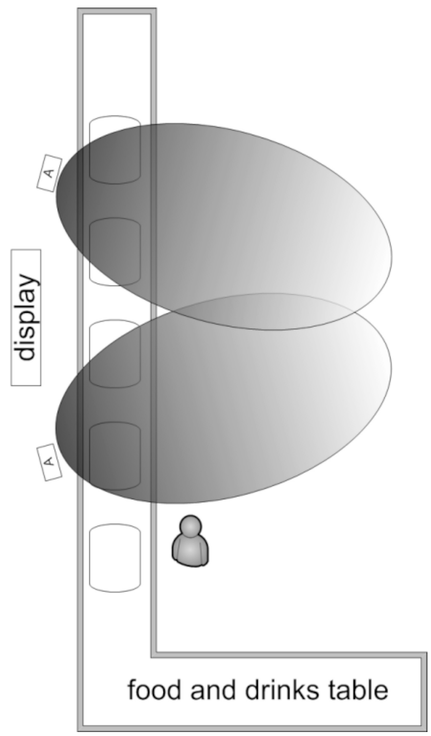

Fig. 5. Ticket2Talk floor plan. Shaded ovals represent the approximate most active regions of RFID antennas.

Fig. 6. Ticket2Talk setting with a small crowd; the display is top center.

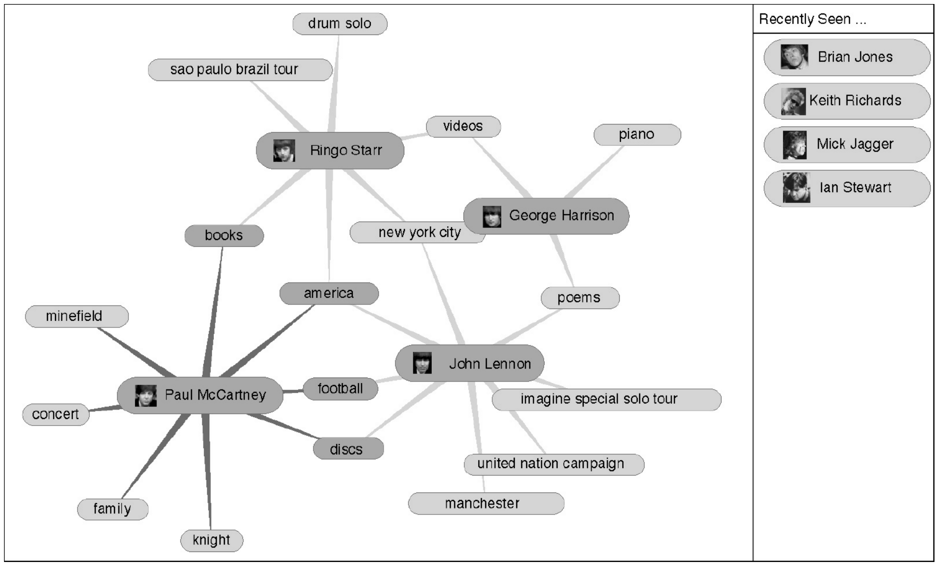

Fig. 7. Screenshot of Neighborhood Window.

explores the enhancement of the "many-to-many" relationships that are not present in ASID or T2T. Like T2T, NW is designed for informal conference settings. For example, during a demonstration session or poster session attendees will mill about, forming ad-hoc groups as they cluster around a specific demo or interesting poster. While T2T could be useful in this setting, NW was deployed to explore a different dimension of the design space.

NW responds to a *group* rather than an individual, exploring the enhancement of the "many-to-many" relationships that are not present in ASID or T2T (which focus on "one-to-many" relationships). It also differs from the other two applications in its use of *implicit* or latent profile information—using words culled from participant's homepages.

NW displays a graphical visualization of conference attendees near the display and links of shared interests. Figure 7 shows a screenshot of NW. There are two types of nodes in the NW graph; people and terms. *People* nodes are labeled with a personal picture and name, and represent a subset of the attendees whose RFID tags are detected near the display. *Term* nodes are labeled with a word or a phrase. Initially, the terms and phrases were set by mining attendees' homepages (the homepage URL is an optional field in the profile database). Attendees could manually set, delete, or modify the terms associated with them at any time, but in practice it seems that few attendees modified or edited the terms in their profile. Terms that were either shared among other attendee homepages or that were unique across the entire population were selected for display. Edges link people with terms. When two or more people nodes on the display share a common term, then the shared term can be visually discovered. A small number of unique terms were also included for each person as these were considered to represent another dimension of conversation-starting fodder.

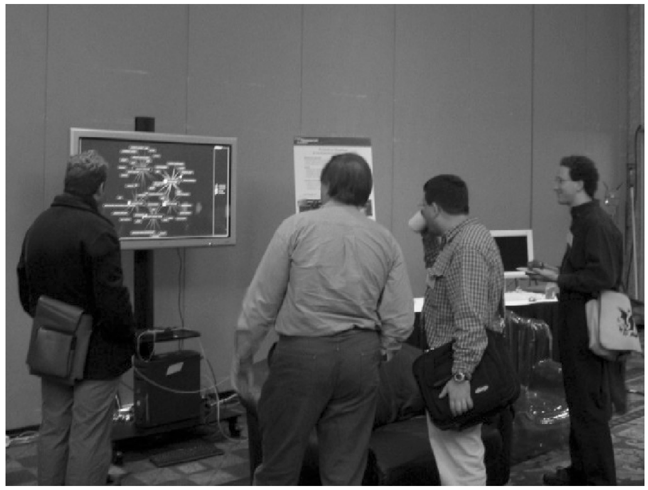

Fig. 8. Neighborhood Window in the context of use.

NW displays up to four people at a time. This number represents a compromise between including as many people as possible while still ensuring the visualization is readable and comprehensible at a distance. NW has a queue similar to that of T2T that lists which attendee will be moved onto the display next. A highlight "aura" moves among the four participants listed on the screen. This aura makes the person node and directly connected term nodes brighter for 5 seconds. The goal of the aura was to highlight a person-centric set of shared and unique interests for prospective conversation.

NW was deployed in a simulated "lounge area." Standing tables and a couch were placed to create a comfortable space where people could congregate and linger for an extended period of time. The NW display was located on the periphery of the lounge so that it could be used to initiate potential conversations but could still be plausibly ignored.

During the conference demonstrations session, the tables in the lounge area interfered too much with the flow of traffic, and were removed. This resulted in an open space where people could stand and watch the display (in effect, shifting it from the periphery to the foreground of attention of those who paused to look). The people in Figure 8 are shown standing (where tables had been), looking at the NW display.

4. DATA COLLECTION AND ANALYSIS

With the approval of conference organizers, we deployed the proactive display systems at a single-track academic conference with approximately 500 attendees. Pre-registered attendees were contacted in email to inform them how to participate and to allow them to create a profile. Attendees could create profiles through the web prior to the conference or on-site. Conference registration information was not automatically included in the profile database.

In order to respect the privacy and choices of individual attendees, participation required three explicit steps. First, an attendee needed to create a proactive display database profile. At any point, an attendee could edit or delete information relevant to each of the proactive display applications. Second, at the conference, the attendee had to get an RFID tag and "activate" it by associating their tag with their database profile at one of two activation kiosks available on-site during the conference.[1] Finally, an attendee needed to actually wear the activated RFID tag. The type of RFID tag could fit conveniently inside their conference name badge sleeve, behind the standard printed name card. If an attendee threw the RFID tag away or left their conference badge somewhere (say at their seat), she would not be detected by a proactive display.

The applications and activation kiosks were deployed for most of the conference, beginning with the demonstration session the first afternoon and ending with the closing session on the third day.[2] Participation—profile creation and tag activation—slowly grew during the last half of the first day through the second day. On the third day, almost no tag activation took place. Total participation was about 40% (201) of the total population of conference attendees, limited, in part, by the shortage of kiosks available on-site.

The data collection and analysis regarding the impact of the displays on the conference attendees relied on standard qualitative methods. Data was collected through systematic observation, short informal interviews, and a follow-up web-based survey of conference attendees. The survey included a mixture of objective, multiple choice and open-ended questions. The methods for data collection were tested during a pilot deployment of AutoSpeakerID and Ticket2Talk during an internal "open house" event three months prior to the conference deployment.

The qualitative data (observations, informal interviews, and free response data from the web survey) was coded using open coding methods [Strauss and Corbin 1990]. Three coders participated in the coding activity. Naturally, different coders see different things in the data. When differences arose, they discussed the data until some agreement was reached. In some cases, this was resolved by selecting one of the existing codes; in other cases, a new code was created; in still other cases, the data was coded into more than one category. The results were then compared to the original design goals.

The majority of the following analysis is oriented around the qualitative results. Before we detail the qualitative results, we first provide a brief discussion of the quantitative survey. Of the 500 conference attendees 94 responded to the web survey (a 19% response rate). A majority of the respondents (68%) reported active participation in the field trial by creating a profile and wearing an RFID tag during the conference. Thus, survey respondents were biased toward participation in the field trial relative to the level of participation by the overall conference population. A majority of respondents (63%) attended the conference for the first-time. First timers strongly indicated that the proactive

[1]Note that the deployment utilized *passive* RFID tags, due to their slim profile and low cost. "Activate" here should not be confused with *active* RFID tags, which typically have batteries, but with the process of linking the physical tag to the online profile.
[2]Networking problems kept the applications from accessing the profile database for the first half of the first day.

Table I. Number of Respondents Assessing the Impact of Each Application as Positive or Negative

Display Application	Positive Impact	Negative Impact
AutoSpeakerID	71 (77%)	10 (11%)
Ticket2Talk	39 (41%)	3 (3%)
Neighborhood Window	21 (39%)	2 (2%)

displays were more likely to help them learn something new about another attendee or interact with someone they didn't already know.

For each display application, the survey specifically asked if the respondent felt the application had a positive or negative impact on the conference. Table I shows the response rates. In general, participants felt the applications had a positive impact.

The following sections present our results structured in relation to the initial design goals. This presentation is not meant to abuse the emergent categories of the analysis. Instead, we present evidence for each design goal, and assess whether each was achieved and if so how. In some cases, the evidence supports meeting a design goal, in other cases, the data suggests that our result is mixed.

4.1 Enhancing the Feeling of Community

One design goal for the proactive display applications was to enhance the feeling of community among the conference attendees. A greater sense of the identities, perspectives and interests of other conference attendees, gained either through direct interactions or through more peripheral means, would provide evidence that an application is meeting this design goal.

4.1.1 *AutoSpeakerID.* Enhancing community is more than simply knowing other people's names or affiliations. It means having a broader understanding about people's background or activities. The most obvious aspect of AutoSpeakerID is that it presents a name, affiliation and photo. ASID generated a number of comments pointing out how the application fills in for what is missing.

> `It was very nice to see people's names an[d] affiliations when they asked questions. I wrote some of them down and contacted them later.`[3]

However, a larger number of comments address the broader issue of making sense of what is going on in the space of a paper session or panel session.

> `It gave me a better idea of who was asking the question.`

> `It was nice to be able to see who was speaking to put their question in context if I didn't hear or forgot the person's introduction.`

These two comments represent an understanding that is categorically different from simply knowing a person's name and affiliation. These comments show that individuals who are in the audience frame their understanding in

[3]The typewriter style font in a text block is used here and in the remainder of this article to indicate a direct quote from a participant. Each quote is from a different participant, unless otherwise noted.

the context of what they hear (or don't hear). The ASID application helped them see what was unheard, reestablishing the framing for questions or comments.

4.1.2 *Ticket2Talk.* Enhancing community can be about increasing opportunities for interaction, the overall number of interactions, or the quality of the interactions. In analyzing what occurred around T2T we first turn to our observational data.

The key to our observational data is not simply observing the individuals' acknowledgment of each other, but that they also acknowledge what is showing (or was recently shown) on the display. Naturally, this is not perfect, but it is the closest we can get to knowing whether the application may have influenced one or more of the parties in the engagement. In the observations of T2T, there are many occurrences of this dual acknowledgement.

> *Two people were getting food at opposite ends of the table. One of the two looked at the display, and upon recognizing the person in the display turned to the other and greeted him. . . .*[4]

In this first observation, one of the parties looks at the display and then recognizes that the person on the display is nearby. There is then an active acknowledgment through a greeting and verbal exchange. Another observation with a similar flavor:

> *. . . One person stops and laughs out loud when the picture comes up on the display. Everyone chuckles and smiles, even the ones in the back row. No introductions.*

We have many observations that demonstrate a dual acknowledgment that begins to frame the impact of the application. Individuals whose tickets were on the display were more likely to be recognized by others who were standing in the vicinity of the display.

A number of explicit survey comments mention how T2T resulted in interaction or conversations. Respondents generally have difficulty recalling specific, casual, incidents like these. Thus, comments by respondents indicate events that were quite significant to them.

```
[I] managed to [meet] in person somebody who I knew by email contact
but have never met before. I happened to be in front of the coffee
desk when his name flashed on the screen. This was really cool.
```

Like ASID, there were comments about the functional qualities of the application; the way it allows an observer to put a name to a face, even when there is no interaction. A few people felt that the applications had negative impact. As well, some comments represent the trade-offs of augmenting a social space. What some attendees like, others might not. One respondent commented:

[4]The use of italicized text in a block is used here and in the remainder of this article to indicate an observational record collected during the deployment. As with quotes, each observation is independent—made by a different observer or referring to a different observed behavior episode—unless otherwise noted.

```
[I] did not like automatic display of my information at coffee area
because it was like a "loud" announcement that I was there...
```

The design and the physical deployment recognized this possibility; that people would not want to be "announced" in a room. So, while T2T was physically near coffee and snacks, there were two other coffee and snack stations that did not have a T2T proactive display nearby.

4.1.3 *Neighborhood Window.* The physical location of Neighborhood Window was somewhat remote from the main conference sessions and breaks. The fewest people interacted with this application and it generated the fewest comments. Still, one comment addressed a community enhancing aspect of NW.

```
It was interesting to see the intersections of my interests and
others' on Neighborhood Window.
```

One attendee commented that, during the demo session, he was standing near NW with some other people who he did not know. When his profile was displayed, he noticed the term "red queens" connected to him and as well as another person he didn't know. He was somewhat baffled how that term was found based on his homepage and commented aloud. At which point, the other person spoke up to express a similar bafflement. The two proceeded to talk briefly about the display and then some of the other demos.

This is interesting because the code used to mine homepages for terms and phrases was rather generic, based on simple open source implementations. At times, terms inserted into an attendees' profile during the mining of their home page did not make sense. Despite the inaccuracy—or, in some cases, perhaps because of the inaccuracy—the desired result was achieved; two people interacted as a result of what they saw on the screen, in a manifestation of object-centered sociality. The commonality they found through that interaction might be more important than the text on the display itself.

Generally, the three applications worked to promote interactions among participants. Some interaction might be the result of novelty, but clearly some of the interactions observed and described by participants were striking enough to remember.

4.2 Mesh with Established Practices

The problem of meshing with established practices involves deciding *which* or *whose* practices to attend to. Not every conference has the same practices and norms, and not every attendee adheres to those practices. Thus, the applications we designed address a relatively narrow range of established practices both within the target conference community and within each of the specific settings in which they were deployed. However, some attention was paid to enabling limited flexibility in the applications; they could be tailored to a range of different conference practices. As well, deploying any technology in a field trial is not neutral. There will be some impact on the users in the setting. One challenge is to understand the significance of the changes brought out by introducing a new technology.

4.2.1 *AutoSpeakerID.* AutoSpeakerID is designed to provide visual information to the audience, augmenting the oral introductions given by question askers at the end of a paper session. The ASID display was smaller than the main screen and situated to the left side of the general session. We also incorporated a fade in/out feature to reduce the flash of a new image on the display. In a prior section, we covered some data describing community enhancing aspects of ASID. Our data here suggests that ASID changed aspects of the general session for both people who ask questions and for the audience.

Prior studies of conference augmentation technologies have rarely identified unanticipated uses of the technology. In our case, attendees were not prevented from creating fake identifications or otherwise subverting the intentions of the system designers. There were a small number of people who created wholly fake identifications (e.g., a "Bill Gates" profile), provided partially false data (e.g., "University of Tigger"), and on one occasion physically switched a person's RFID tag. Surprisingly, the feedback on the impact of this "gaming" was mostly positive, with many people indicating they enjoyed the fun of gamed profiles. For example:

```
It was great to see people having fun with it entering comical names
or affiliations. It lightened the feel of the paper sessions.
```

While many comments point to the fun and interesting aspects of gaming, it would certainly be problematic if taken to an extreme. From the perspective of some respondents, the gaming distracted from the quality of the intellectual exchange. In the following comment, the person questions the motives of the person asking a question.

```
Some question askers seemed to be asking questions just to
demonstrate their manipulation of the RFID system. So when "Bill
Gates" asked a question I wondered whether he really cared about the
answer or just wanted to make a public display.
```

Gaming was actually not very prevalent. Through observation, we know of only three individuals who asked a total of seven questions while some amount of false information was contained in their profiles. On several of these gaming instances, laughter erupted among the audience, which caused a pause in the question and answer session. Interestingly, the audience laughed less in successive instances.

Another impact we observed was the audience collectively turning their heads toward the ASID display, to the left of the general session room instead of focusing on the speakers at center stage. Some respondents indicated that the ASID was distracting to audience members. Questioners altered their normal question asking behavior. Some fiddled with their badges, paused for their profile to appear on the ASID display, commented on whether or not they were wearing an RFID tag, or stopped offering an oral introduction altogether. Although there were only a small number of examples of each of these behaviors, they created a particularly strong impact on a few of the respondents.

```
Honestly I found the speaker-id a distraction. Every person that
walked up to the mike seemed compelled to either pause while they
```

```
looked at their description or mumble something about not having
gotten a tag yet.
```

It is problematic to assess how well ASID meshes with existing practice. In normal question and answer sessions there are no opportunities for the type of visual gaming we observed, though some oral humor on the part of a questioner is not unusual. In reality, only a small number of individuals actually gamed the system explicitly. But the augmentation of practice generated a large number of comments related to how it changed the feeling of the session. It is also clear that the system led to some distraction that was not viewed positively.

If a system like ASID is designed to augment current practices, then a questioner should probably continue to be encouraged to orally state name and affiliation when asking a question. As some participants became more comfortable with the ASID, they stopped any verbal introduction, transforming the role of ASID from augmenting existing practice to creating a new one.

4.2.2 *Ticket2Talk.* The Ticket2Talk proactive display was situated in a coffee break area, behind a table with a coffee urn and other refreshments. Casual conversations among people moving through the line are not uncommon at conferences, especially among "veterans" who have attended a conference in previous years. T2T was designed to augment this practice by providing visual content that might help initiate more conversations, especially for the benefit of relative "newcomers" who have never attended the conference before. We hoped to promote casual conversation without distracting participants from the refreshments available during breaks—which might slow down the movement through the line to an unacceptable pace—or violating social norms—such as making people feel compelled to say something. In a previous section we presented data describing how T2T fostered interaction. However, as with ASID, we also observed instances of new and different practices around T2T.

A few attendees may have had difficulty understanding the interaction model of the proactive display. Some participants expected an instant response from the display when they approached. In some cases, when their profile did not appear immediately in the central display area or lower queue, they resorted to waving their badges or pacing back and forth to get the attention of the proactive display. Consider the following observations:

> *People walk up with a big smile. Look at the person standing next to them and again at the display. Is that you?!? One is waving RFID tag in front of reader. Pick me up!*

> *Two people at the table, one person walks up to reader and back. They are moving back and forth trying to get picked up by the reader.*

In the T2T application, when a participant's profile did not instantly appear, some reacted with nonstandard conference behavior, badge waving and pacing back and forth in front of the display. This behavior is not exclusive to T2T. This behavior is similar to pressing the "close door" button in an elevator multiple times or shaking a computer mouse trying to urge the computer to react. Thus, in groupware applications like T2T, mediating the shared interaction and shared control present distinct challenges both for users and for designers.

On the other end of the spectrum, a few of the attendees were so engrossed by the display, they appeared to take no notice of the other people around them. The following three observations describe the behavior in more detail.

> *Many were transfixed and literally stopped all movement while watching. This can be more distracting than conducive to social interaction.*

> *People tended to watch the display like a TV.*

Staring at people is usually considered socially unacceptable behavior, however staring at people's digital representations of themselves, via their tickets to talk, seemed acceptable to at least some of the attendees. While not part of established practices in this conference, and in some cases in conflict with the goal of promoting face-to-face interactions, this behavior may have resulted in greater awareness on the part of those who were transfixed by the T2T display.

4.2.3 *Neighborhood Window.* While we don't have the same quantity of data for Neighborhood Window[5] there is evidence that users are not always aware when gaming is taking place. At some point during the conference an activated RFID tag was taped to the reader at the NW display. This caused a person node and associated word nodes to appear and remain active on the display when that person was not physically present. Based on our observation, it was unclear to a few participants how this user came to be displayed and they spent time trying to make sense of it. Their reaction was to make assumptions about the system instead of considering the possibility that gaming was occurring.

While more effort can be made to increase the possibility of meshing with established norms and practices, there is no way to install new technology that is to be used by people and not change existing common practices and behavior. In hindsight, it may have been a poor choice to set out such an unrealistic design goal. The question is whether or not the inevitable change in behavior should somehow be mitigated by design. In the case of proactive display technology, we have seen that social practices can constrain use and enforce norms when it is important to the community.

Meeting the design goal of meshing with existing practices is, perhaps, overly challenging. The problem as presented in the opening of this description, designing to mesh with which or whose practices, cannot account for the changes resulting from the introduction of the technology. The straw man case is that the best way to mesh with existing practices is for there to be no changes. Our applications and field trial could never meet that goal. From the data, it seems clear that there are positive aspects to the way the applications augmented practices, but that some resulting new practices could be distracting.

[5]As we mentioned, Neighborhood Window was in a physical location somewhat remote from much of the conference activity, thus we were not able to collect as much observational data. This is similar to the decline in responses illustrated in Table I.

4.3 Managing Privacy Concerns

Respecting privacy, as a design goal, while still offering opportunities for revelation on a large shared display, is a challenging combination. On-line privacy is a complex problem that the research community is only beginning to address in small ways [Palen and Dourish 2003]. Proactive display applications need to manage privacy in three domains; the online, the face-to-face, and the bridge between. For example, in the online space the profile information needs to be controlled and managed in a way that shows respect for individual choice. In face-to-face, the system needs to support the choices individuals would make in a public setting, like avoidance. And, in the bridge between them, when a profile is displayed, individuals should be able to plausibly ignore what is going on around them.

To respect the privacy of attendees, our system specifically required several "opt-in" steps. One of those was that an attendee needed to create a profile. Preexisting sources of data may tempt designers to make things easier on the user. This research community has a community website modeled after CHIPlace and CSCWPlace [Churchill et al. 2004]. It would have been simple to migrate all of the data from the community website and/or the conference registration database into our database, saving the users one or more steps. The profile creation "opt-in" allows a user who had a community profile to populate specific fields from their community profile, but other fields had to be entered by hand. If a user did not have a profile on the community site, then the entire web form had to be filled in manually. This approach was not without comments.

```
... Would have been nice if it could have been pulled automatically
from my registration.

I wish that in future conferences when someone signs up they
automatically have an ID tag in their badge when the register ...
and then they can chose to add pictures and interest when they want
otherwise the system would just show their name and affiliation.
```

In the face-to-face dimension, other decisions were made to help manage privacy. The profile information from our database was only made available on the proactive displays, and only when the person with whom the information is associated was in the vicinity. It is certainly possible to make this information accessible in other places or at other times, say through a web page. By restricting the presentation of the information in the physical space of the conference, privacy norms that are similar to those in face-to-face situations can be established. Comments from attendees fall on both sides of this issue. Some wanted more access to the information on the displays while others wanted the technology to support different activities.

```
... follow-up was frustrating. [T]he apps were useful in helping you
identify people you might be interested in meeting BUT there was no
subsequent way to make those people aware of your interest and hence
no good way to rendezvous.
```

This respondent was noting specific problems that he had and suggested changes that may help solve that problem. But the suggested application may not fit within the scope of what is possible with proactive displays and may violate common norms in a conference setting. Finding another's location, or receiving messages from unknown strangers for a 'rendezvous', raises the specter of digital stalking, potentially bridging the gap into the physical world. Our evaluation shows that, despite our careful attempts there are still concerns when any kind of personal information is used.

> ... At Interact I participated in a similar project which used handhelds to facilitate networking. I am a female researcher so I was a bit unnerved that [a] male conference attendee sent me a message at midnight ...

This comment illustrates a concern about how information (and a technology) is used when the owner is not present as well as when the owner is present. The comment is not about our application but another conference augmentation system using handheld wireless devices. It serves to highlight the important privacy challenges that must be effectively addressed for the success of any technology that is intended to augment a social space.

Overall, the number and range of comments about privacy issues was remarkably small. The presentation here might seem to make privacy a bigger issue than that which was expressed in the data. Given the range and type of comments, the applications seem to have handled privacy relatively well.

It is possible that our attempts to manage privacy were overly cautious. Our three-step "opt-in" approach required more effort for people to participate than an opt-out or less conservative strategy. As a result, some participants specifically mentioned that they did not participate because of the effort threshold. But on the positive side, the policy resulted in very few complaints being registered about privacy before, during or after the conference, suggesting that by that measure, the design succeeded.

5. DISCUSSION

The results of our deployment can be framed relative to some established discussions in the HCI and CSCW research literature. While we know of no specific studies of public interaction in academic conferences, some work of Goffman [1963] does characterize how people participate in fluid social spaces like conferences. As well, our results speak to the ongoing discussion of awareness and shared interaction for groupware applications. We cover each of these in turn.

5.1 Behavior in Public Places

One important theoretical framework useful for interpreting these results is that described in *Behavior in Public Places: Notes on the Social Organization of Gatherings* [Goffman 1963]. In the following we frame our results relative to aspects of this work. However, before elaborating our findings relative to this framework, we recall for the reader a few key concepts.

An academic conference is example of what Goffman defines as a *social occasion*; which is a gathering of two or more people interacting in a *setting* (the broader situational context). Goffman briefly distinguishes structured social occasions with agenda, organization and management, with sanction for improper behaviors, of which a conference is surely an example, from the less structured or recreational occasions. Few, if any, of Goffman's key examples span multiple days and multiple physical settings. The prospect that an academic conference contains or subsumes a number of instances that could be defined as a social occasion still fits within Goffman's characterization. For example, many conferences have receptions which themselves would constitute a social occasion in Goffman's view. A composite social occasion is still a social occasion.

Conferences include many opportunities for unfocused as well as focused interaction. Goffman defines *unfocused interaction* as "the kind of communication that occurs when one gleans information about another person present by glancing at him, if only momentarily, as he passes into and out of ones' view" [Goffman 1963, pg. 24]. While Goffman is specific about vision as the primary mechanism for collecting this information, his definition and the many examples all point to what we now regularly characterize as awareness. Thus, Goffman's unfocused interaction is how individuals maintain awareness of others in a public setting. This is important because we later interpret our results and the distinct uses of proactive display technology with regard to awareness in a public setting. In essence, Goffman and our discussion of awareness in a social setting are compatible, if slightly different, views of the same phenomena.

In contrast to unfocused interaction, *focused interaction* is concerned with "clusters of individuals who extend one another a special communication license and sustain a special type of mutual activity that can exclude others who are present in the situation" [Goffman 1963, pg. 83]. When two or more individuals are involved in a focused interaction, they are said to be *engaged* in an interaction. Engagements have different characteristics depending upon whether the participants are *acquainted* (mutual cognitive and social recognition of each other) or *unacquainted*. Lastly, engagements are said to be *accessible* when it is possible for the bystander to become involved in the engagement. Goffman's discussion of accessible engagements is important because it describes social mechanisms for growing focused interaction beyond simple dyadic engagements.

Ticket2Talk and Neighborhood Window served to bridge between acquainted and unacquainted engagement. Goffman notes that for acquainted parties it is often the case that they need an excuse *not to interact,* but the unacquainted often need some reason *to interact*. T2T and NW served as a mechanism for unacquainted people to signal a willingness to interact. In the case of T2T individuals picked something they would be willing to discuss. Whereas, in the case of NW, items where mined from participants public web pages. In both cases, the information presented provides a bridging mechanism; an excuse to interact for those unacquainted.

Goffman points out that many communities have *open regions* that are physical places where both the acquainted and unacquainted have the right to initiate an engagement. Conferences themselves are not an open region. Status differences between participants are one boundary that can preclude mutual recognition necessary for an acquaintanceship that leads to a face engagement. The data suggest that Ticket2Talk and Neighborhood Window influenced their settings to create open regions in the vicinity of the display. This is in addition to the information on the display. We had several comments from participants who sought out specific individuals for an interaction when they saw that the person was in the vicinity of the display. The subsequent interaction was not about what had been on the display but was about prior research or possible jobs.

One concept that we introduced earlier as plausible ignorability has roots in what Goffman calls *shields* or *shielding*. These are devices and behaviors that allow individuals to signal that they are not open to an engagement. The shield allows an individual to make the claim that they did not see or know of another's presence. One classic shield is reading a book or newspaper when eating alone at a café or restaurant; a more contemporary example is listening to a portable music player via headphones on a bus or train. But positioning in a room or body idiom (stance) can also be used as a shield.

In our design, we set the time that any piece of information is displayed on screen to a relatively short period. That design decision provides a shield which either party in a potential engagement might use (plausible ignorability). We did not conduct a systematic experiment to parameterize the on screen display time, and we have no data to speculate as to how long would be too long.

Auto Speaker ID supports a slightly different setting from that of T2T and NW. ASID was designed to facilitate a type of interaction that occurs in a conference technical session. Goffman distinguishes between large groups participating in many different focused interactions (a *multifocused gathering*) and those where a single participant *exhausts* the setting (a *fullyfocused gathering*). Technical sessions at a conference can be characterized as fully-focused, with the acknowledged caveat that there could be side involvements by some participants. However, those side involvements are generally conducted in such a way as to not detract from the current presenter (see McCarthy and Boyd [2005], for a notable exception).

ASID serves to support fully focused engagements such as those in conference technical sessions. By displaying information about an individual who is asking a question, it serves to diminish several openings that that could lead to side involvements (e.g., "Who is that?" "What did they ask?" "Where are they from?"). Goffman points out that in cases where side involvements predominate, the situation changes from being fully focused to multifocused. The issue that ASID itself became an opening for side involvements, through gaming and through people attracting attention to their use or nonuse of the system, would seem to be more about the novelty of the technology and not a long term effect of ASID.

5.2 Awareness in Social Settings

An academic conference represents a different type of "work" than that which is commonly studied in the field of computer-supported cooperative work. The "work" of an academic conference is in large part about finding, initiating, and sustaining face engagements. Some would argue that conference "work" is about the intellectual topic of the conference, and to a degree that is true. But the topic serves to draw the participants and focus the interactions; the topic is a "means" to get to the "ends" of interesting engagements.

This notion of "work" has little in common with that of a control room. However, awareness is clearly important to both situations. Rodden [1996] extends the concept of nimbus and focus introduced by Benford and Fahlen [1993] to general collaborative applications, presenting a model of awareness that could be used in system designs that do not carry a spatial metaphor. The more a person intersects with your *focus* the more aware you will be of her. And the more person intersects with your *nimbus* the more she will be aware of you. Awareness can then be defined as a combination or overlap between one person's nimbus and another person's focus. Goffman's term unfocused interaction is how he accounts for the potentially intermittent intersection of one person's focus with another's nimbus.

Applications such as AutoSpeakerID and Ticket2Talk, deployed in semi-public spaces, effectively change a single participants' nimbus in a profound way. The participant is on the display briefly, but many more people are likely to catch a glimpse of who is asking a question or who standing near the coffee urn. Some people will benefit from this expanded nimbus by being engaged in a face interaction as a result. However, others are less comfortable with the proposition; they do not want a "loud announcement" of their presence. But awareness in this setting goes beyond simply taking turns expanding one and then another persons' nimbus.

The proactive displays attract the focus of those within gazing range of the displays. Certainly, because of the nature of this field trial, our displays got more attention than if the technology was commonplace. That the display attracts attention creates a design challenge for this type of groupware. There is a delicate balance between peripherality and focused attention in the design of any proactive display application. If the display never attracts attention, it would not be useful and if it attracts too much attention, it will not be peripheral. In the case of the displays used in this field trial, the displays, and the participants' choices of information presented, serves to shift the focus of the audience. In a setting like that of T2T, the shift in attention can be described as similar to the way individuals will scan a crowd while still involved in a small group conversation. In that case, the T2T display supports a type of peripheral awareness common in that type of social interaction. However, in a situation like ASID, the shifting focus can be more distracting. The combination of increasing one persons' nimbus while attracting the focus of the group clearly changes the dynamics in the question and answer sessions that follow a technical presentation.[6]

5.3 Shared Interaction

The results of our field trial relate to another groupware problem: the interaction model of a shared application. Researchers have been working on shared interaction in groupware for several years [Dewan and Choudhary 1995; Gutwin

[6]Individuals recognize the value of the question and answer session after a technical presentation for creating a larger nimbus. Sometimes an individual will ask lots of questions throughout a conference to gain exposure. In fact, some academics encourage students and newcomers to do this as a means of becoming well known in a research community.

et al. 1996; Gutwin and Greenberg 1998]. The solutions and design guidelines for groupware only partially apply to the problems of a proactive display. Prior work on sensing systems has identified similar problems [Bellotti et al. 2002]; but identifying problems does not always lead to easily workable solutions.

Consider the problem of providing feedback to the user(s). In an application like ASID, the data reveals some confusion about how and whether the system is working. When a tag is read, and the participant has set up a profile, her name, affiliation and photo is shown. However, in the case where there is no tag, and thus nothing for the RFID antenna to read, it is difficult to do something proactive. In this situation, the system does not know that an individual is at the microphone stand; but the audience clearly knows. Based on our data, some members of the audience will make the attribution that the system is not working, perhaps based on the assumption that *all* attendees are participating (i.e., all attendees have a profile and an activated tag associated with it).

Some proposed solutions work for limited cases, but do not generalize. In the case of ASID, one solution might be to add another type of sensor (e.g., a pressure sensor on the floor near the microphone stand) and perform sensor fusion to disambiguate the situations. The display could then at least note that the system recognizes when a person is at the microphone. However, this technique does not generalize; it does not resolve the problems experienced with T2T.

In the case of T2T, we saw badge-waving behavior that suggests a need to represent each and every badge read. As a way of recalling the problem: our design had a visible queue length of 4 people, which turned out to be too small in the setting of a coffee line in which people linger for an extended period of time. One solution is to dedicate more screen real estate to representing explicit badge reads (say with picture or name). However, T2T could easily read more badges than there is screen space to represent each read, so this solution does not easily scale.

Lastly, some of the problems we observed with these applications relates to the expectations of an "interaction society." The usage model of a proactive display is not familiar to many. In our society, we are usually faced with devices that require our explicit attention and foreground interaction; physical buttons must be pushed, icons must be clicked, door handles must be pulled. As we move to environments that sense and respond to us without our explicit attention, we will not always know when and how to act, react, or interact. This problem is a specific challenge for the Ubiquitous Computing community as it moves away from pure technology development toward the testing and deployment of systems with real users.

In our case, an interaction model for proactive displays will need to resolve the standing expectation that a display will respond to the user's presence immediately. The assumption that a device responds to an individual is part of the everyday "one user, one machine" interaction prevalent in what are largely personal technologies. Groupware and communityware situated in settings beyond the desktop environment break this expectation in ways that we are only beginning to appreciate.

5.4 Designing Proactive Display Technologies

We started our project with a specific set of design goals and with a specific idea about what type of technology we would use. The results of our field trial speak to a set of broader design considerations for proactive display technologies that would be placed in public settings. We classify our design considerations broadly as *Context(s)*, *Content*, and *Control*.

5.4.1 *Context(s).* Context requires considering where displays will be placed and what social activities typically occur in those locations that will be augmented or disturbed. T2T and NW were designed for informal locations. In particular, T2T was designed to acknowledge the type of queuing and shuffling behaviors that happen near a refreshment station. ASID was specifically designed to support the fully focused engagements in a technical session.

We believe that some of the power of a proactive display is that it sits in the periphery of a given context. Thus, the design should seek to minimize activity that distracts from the primary social activity. Augment and extend is the most desirable target for a specific context. Given our data, activities like gaming are not that prevalent, even if they stood out in the minds of the participants. And since they attenuate over time, they should not be the largest concern in an effective design. As well, it seems clear that some of these activities are important to the setting—and important for effective appropriation activity in the setting.

Consideration should be given to where **not** to place displays as well as where to place them. When deploying T2T there was specific consideration for providing refreshment stations that were not augmented with a proactive display for individuals who wanted to avoid the display. This could also have been achieved with ASID if the conference had provided two microphone stands instead of just one; we could have had one microphone stand with the ASID reader and the second without, but even then we wouldn't distinguish whether people were simply choosing the closest microphone, or the one with the shortest line.

Considering the context requires understanding how the deployed technology can be tuned. All of our proactive displays used similar RFID technology, but with different ranges for reading the tags. For ASID, we attenuated the gain on the antenna so that the RFID tags were only detectable from a range of one meter; for T2T and NW, we used the normal antenna settings, for an effective tag detection range of approximately five meters.. This range will influence the open region around a given display creating a space near the display with different social characteristics for the rest of the space. Consideration should be given to ways of subtly indicating that region.

5.4.2 *Content.* The information on the display is critical to affecting the desired behavior around the display. In our case, we very carefully considered the content and provided mechanisms for overriding the content should an individual's selection be deemed inappropriate for a specific setting. Providing examples of what kind of things might be contributed certainly helps shape the character of the content for displays like T2T and ASID.

While we were clear with our participants about how and when their content would be displayed, several individuals indicated that they wanted to have finer grained selection of what content to display when. We consider providing that level of control over the content itself to be an area for future research.

5.4.3 *Control.* Considering how users will control—or influence—a proactive display is critical. Just applying more sensors to a proactive display can make some differences. For example if we had included a simple pressure pad in the area around the microphone for the ASID, we could have made it clearer to the audience that the system distinguished between users who wore RFID badges and those who chose not to participate. But simply adding more sensors will not resolve the more general problem of mass interaction and control over a single display. This is clearly an open problem worthy of further investigation.

The principle concern that users have relating to control of these technologies is how they could potentially create privacy violations. It seems clear from our data that opt-in strategies are effective at mitigating user concerns about how and when their information will be presented. Our multiple opt-in steps may have provided too many barriers to participation for a number of the conference attendees. However, as obvious as this may be, the design should make it simple for users to import data from other sources.

Additionally, proactive displays can rely on existing social norms if they are appropriately designed to account for a social and physical context. In our case we designed the applications to require co-presence of the person and their information. That is, information about a person was only presented when they were physically present and willing to participate by wearing their badge. This removed the possibility of digital stalking and could then rely on the common social norms around physical presence. How proactive displays influence the intersection of digital representation (the user profile) and the physical representation (their person) is an interesting open question that our data does not adequately address.

Lastly, in groupware applications like T2T and NW, mediating the shared interaction and shared control present distinct challenges both for users and for designers. The issue of control is further exacerbated in the case of a proactive display where the system sits in the background and only *reacts* to users rather than *interacting* with them. In one case of NW individuals around the display generated several different models of what the display was doing in response to behavior they could not quite understand. Consideration should be given to the representation of the systems activity and representing how it responds to the environment.

To be fair, we did not completely ignore the issue of visually representing the system activity. Both NW and T2T had visual representations of the queue of users waiting to be displayed. In the NW case, the number of people around the display was relatively small and the visualized queue of profiles waiting to move onto the display was relatively effective. However, with T2T, the crowd around the display overwhelmed the visual representation we allocated to the queue, making it difficult for participants to see if they were in the queue or not.

6. CONCLUSION

Modern sensing technology and cheap displays are increasingly being deployed in public social spaces. Fluid social spaces, where individuals come together, small groups form and re-form for the purpose of social interaction, are important to our communities. Whether these technologies will facilitate or hinder our social engagement is a function of the interaction design, the settings in which they are deployed, and the content on display. These three key aspects—Control, Context, and Content—are critical to how these technologies impact our social spaces and whether they are ultimately accepted or rejected.

We have presented the results of a technology deployment to augment a fluid social space; an academic conference. The data we collected indicate some success in creating greater awareness and interaction opportunities within the conference community. However, they also show we were less successful in seamlessly meshing with the common practices at the conference. Indeed, we have begun to re-examine this design goal in light of our experience. Meshing with existing practices may not be a reasonable goal in a large group setting. The variation of practices in physical social spaces within a large community or group may be too large to reasonably meet the design goal. Our policies and processes to protect privacy may have been overly cautious, as the suggestions for broadening the scope of when, where and how profile information was collected and disseminated outnumber any concerns voiced about privacy.

This field trial offers an opportunity for reflecting about how we can extend concepts originally developed for the on-line world into the physical world, and, perhaps most importantly, to the bridge between these worlds [Gershman et al. 1999]. As computing capabilities continue to migrate beyond the desktop and into new physical settings, it is increasingly important to consider how these capabilities can help—or hinder—social activities and practices in these physical spaces.

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