"Status on Display:
A Field Trial of Nomatic*Viz"

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ABSTRACT
Widespread distribution of personal status messages is infiltrating popular culture through media such as instant messaging (IM), social networking websites and mobile phone applications. However, the behavior and implications of status broadcasting in the milieu of social group life is still poorly understood. In this paper, we present the results of a field trial in which we examined how the social life of community members is organized in the presence of multiple status broadcasting services. We designed Nomatic*Viz , a situated public display showing people's location and activity status as an additional way of viewing context information provided by an existing instant messaging status distribution tool. Through a five month field study of its use we uncovered how people daily encounter, perform and negotiate self-representations through multiple simultaneous displays of personal status.

Author Keywords
awareness, computer-mediated communication, context-aware computing, large public display, presence, social computing, status, visualization

ACM Classification Keywords
H.5.3 Group and Organization Interfaces: Collaborative Computing

INTRODUCTION
As early as 1971, networked Unix computer users were using utilities to see the *status* of other mainframe users. By combing commands such as "who", "ps", and "finger" [24] people were given a way to describe their current workload and account for the usage of shared computing resources. A related concept, *presence*, developed as an indication that someone is in a digital or physical space [8]. This concept came about largely as the result of the increased availability of cameras, and other sensing peripherals. Projects such as MediaSpaces [2] and Portholes [7] both showed the value of this kind of awareness amongst remote collaborators.

As the internet has become more central to daily life, and as mobile computing has increasingly reduced the time when people are offline [11], these two concepts have become more intertwined. Their hybridization has been seen in research [18, 14, 6], in instant messaging, and is supported in popular social networking services such as Facebook, Twitter, and Jaiku[1]. While these services provide support for quick status message authoring and sharing, other services support cross-service aggregation and redistribution such as FriendFeed and Ping.fm[2]. Most of these sites also offer mobile clients. However, the behavior and implications of this new kind of status broadcasting in the milieu of social group life is poorly understood. There are many factors from both an individual and group perspective that have yet to be examined.

In this paper we report on explorations of how aspects of social life are shaped by and are themselves shaping, status broadcasting. We did this by designing, deploying and empirically evaluating a display of community status messages and sensed context, called Nomatic*Viz in a public location. We focused our investigations on the Nomatic*Viz system instead of on other existing social media because we wanted to include a view of status which provoked reflections on participants' roles as *members of a community* rather than simply as a collection of individuals - a notion that IM buddy lists reify. Using ideas described by Sengers, *et.al.* [21] we attempted to leverage user reflection as an important means for us to uncover unconscious values embedded in status broadcasting technologies and related practices. To this end, we conducted a five month field study of Nomatic*Viz located in an academic department lobby (see figure 1). Sixteen participants published their status through the display everyday, seven of whom were interviewed.

The Nomatic*Viz display shows personal status such as location, activity and mood information in an ambiguous and abstract manner (see figure 4). The source for the status information is an open-source, context-aware software tool called Nomatic which runs on personal computers. Nomatic uses a wide variety of built-in sensors (*e.g.*, WiFi access points, built-in accelerometers, network information) to sense aspects of a user's context, to remind users to update their status when their context appears to have changed and to broadcast their status to IM services *and* Nomatic*Viz . In addition, Nomatic use machine learning to make entering

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[1]www.facebook.com, www.twitter.com, www.jaiku.com
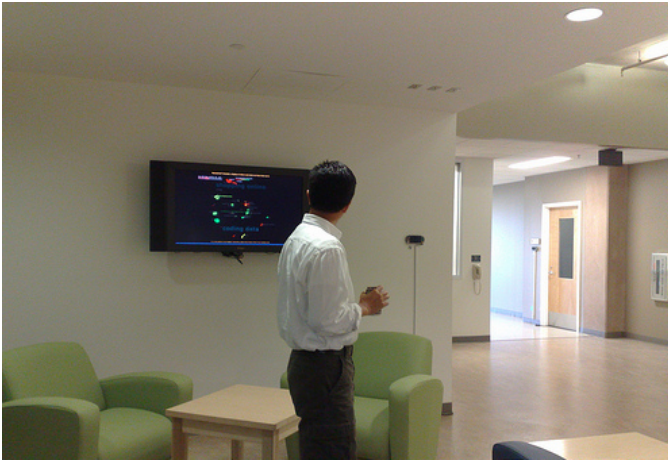[2]www.friendfeed.com, www.ping.fm

Figure 1. A passerby glances at the Nomatic*Viz display situated in its public community space.
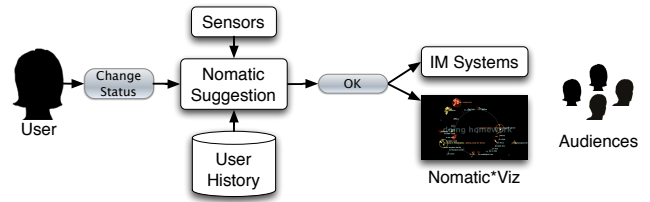

Figure 2. When a user wants to change status, possibly at the prompting of the system, Nomatic uses sensor data to provide suggested status messages. When a user selects a status message it is sent to many different status broadcasting systems and Nomatic*Viz .

routine statuses as simple as selecting from a list of suggestions [20] (see figure 2).

Through the display design we sought to leverage ambiguity to create a thought-provoking and reflective visualization of the entire community's sensor and status data. In the spirit of Gaver's work [9] we wanted to focus Nomatic*Viz's audience on the interpretation of the overall rhythm of the community and not on the specifics of the sensor data that were being reported. Although the same status data were also being reported to other social media such as IM, Nomatic*Viz had some specific differences:

- **Anonymous**: Unlike an IM buddy list the Nomatic*Viz display does not explicitly associate status messages with users. It is not straightforward to see who is generating the status data, and in this way it was designed to protect privacy and to require a user's knowledge of the community for effective interpretation.
- **Physically Situated**: While IM buddy lists can be viewed anywhere with a network connection, Nomatic*Viz is only viewable in the one physical location.
- **Individual Ambiguity**: Nomatic*Viz does not use individual icons, photos or names, but only slightly different shades of colors to represent individuals. Because all of the reporting sensors are aggregated, the interpretation of the data is more group oriented with only ambiguous implications for individuals.
- **Display Ambiguity**: The sensor information is displayed in a iconic manner which is not interpretable without learning about the system through usage. In particular, although the display shows location information, it is not mapped to geographic positions but is instead dynamically determined by participants' collective interactions with the WiFi infrastructure
- **Public**: Unlike an IM buddy list, Nomatic*Viz is in a publically viewable location.
- **Persistent**: While status in an IM buddy list is ephemeral, Nomatic*Viz aggregates and retains some status data on a weekly basis.

In the following sections, we discuss the relevant literature, the design, the deployment and the evaluation methodology of Nomatic*Viz . We then go on to synthesize a series of themes that emerged out of our qualitative analysis of the data. While these issues are specific to our particular case, they suggest social patterns that will resonant in other status broadcasting systems.

RELATED WORK

Nomatic*Viz builds on previous work at the intersection of context-aware computation and situated large displays. It particularly emphasizes the communication of context for social awareness.

Sensing Context for Social Awareness

Automatic sensing combined with context modeling technologies have long been explored as a means for giving computers and remote observers insight into non-native environments. For remote observers such insight can reduce the overhead of communicating with distant collaborators and promote community [7]. It can assist in choosing an appropriate time to interrupt [15]. It can help to support coordinating face-to-face meetings [13, 18] and it can physically locate members of a community [25].

Automatic Sensing and Labelling
Recent work has combined sensing with semantic labeling to provide lighter weight interpretation of sensor data for appropriate communications. For example, the Awarenex system included the ability to associate manually entered labels with device detected locations [23] and then to distribute the labels to social contacts. WatchMe is a tool based on interpreting sensors as graphical icons to communicate remote context between members of close relationships [16]. Reno allowed users to associate labels to cell tower connections and then activate rules based on entering those zones [22]. Using a very different user interface, but similar underlying technology, the Whereabouts Clock allows users to associate three labels (work, home, school) with cell phone towers for the purpose of communicating vague locations to family members [3]. Finally, Connecto allows users to associate labels with combinations of cell-phone towers [1] and IMBuddy with combinations of WiFi access points [12]. Combining sensing and manual labeling not only addresses coverage and bootstrapping issues, but also gives users more sense of control for personal status disclosure, which is critical for the adoption of status sharing systems.

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Nomatic

Nomatic is like the previous systems in that it attempts to map labels to sensor data and to communicate those labels on behalf of users [20]. But unlike the previous systems it treats labels less strictly as descriptions of locations and more flexibly as statuses composed of "places", "activities" and "moods". The difference lies in relaxing the one-to-one mapping of physical locations to labels so that a location can be a "classroom" in the morning and a "conference room" in the afternoon. It employs automatic sensing to suggest a current status and also detects changes in context which acts as a reminder for status updates. Unlike other context-aware supported social awareness systems, Nomatic is focused on mobile laptop use rather than on wearable devices or cell phones, and as a result leverages the associated unique usage patterns.

Large Displays for Social Awareness

For this field trial, Nomatic was adapted to report information to the Nomatic*Viz large display in addition to online social awareness systems. As such, it builds on recent interest in investigating how to use large displays to enhance interactive and collaborative experiences, and to foster community awareness. A brief description of some of those systems follows:

The Notification Collage was a groupware system based on a collage metaphor which allowed a variety of media elements such as video, slideshows of photos, desktop snapshots, sticky notes, etc. to be posted to a large screen display. These elements were provided by and shared within an intimate collaborative group. Investigators found that the Notification Collage supported a range of interactive and collaborative practices and that the form-factor and location of the large screen display mattered as the display was interpreted differently when viewed on a desktop computer. Large displays also introduced new concerns around privacy violations and distractions associated with the public posting of digital media [10].

The Plasma Poster Network was a series of interactive public displays installed to promote community through digital technology while individuals were themselves offline. With the support of an underlying infrastructure for content storage, distribution and publishing, it sampled and broadcast relevant materials from an intranet such as technical reports and meeting calendars, and also allowed authorized members to publically post content. The study of the Plasma Poster Network emphasized how its value was tied to the situated nature of the display: it's location in relation to the community and their routines [4].

IM and large displays

Perhaps most related to Nomatic*Viz is Huang *et.al.*'s IM Here system [14] which looked in depth at an application that allowed users to IM messages to a large display. In a similar style, Nomatic*Viz also leverages the collocation of the display with a community space to address some privacy and content relevance concerns. In contrast, however, Nomatic*Viz acts primarily an observational awareness system.
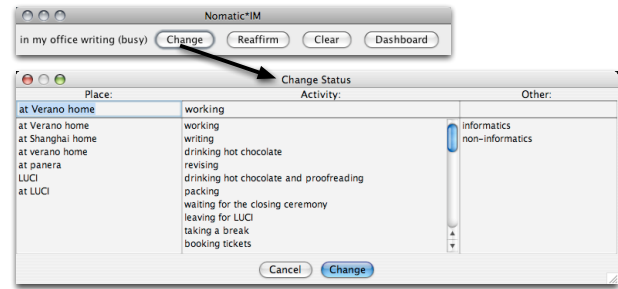

Figure 3. The primary Nomatic window shows the status that is currently being reported to social media. When a user wants to change his status, he is provided with a list of suggestions that are generated by a machine learning algorithm that matches current sensor readings to previously used status.

Users can not control or post data on Nomatic*Viz except through secondary effects of manipulating their physical and social behavior.

Together this work demonstrates that large displays have unique affordances. Compared to more traditional desktops or mobile phones, they are physically persistent, situated, and often shared, and as a result support low overhead awareness and information exchange, creating opportunities for conversations and community engagement.

SYSTEM DESIGN

IM and Nomatic

Current IM systems support awareness of contact ("buddy") status as well as text-based communication. Buddy lists are often augmented with two types of status cues. The first is a short user generated *status* phrase. The second is a simple automated *presence* indication of whether the buddy is "offline", "away", "idle", "busy", or "online" typically generated by observation of keyboard interaction. Both cues are broadcast to a user's entire buddy list.

Nomatic was designed to explicitly merge those two types of awareness cues. It uses a wide variety of built-in sensors on a user's laptop to sense aspects of a user's context. Unlike IM presence cues, which are almost raw sensor data (*e.g.*, "idle"), Nomatic uses machine learning to present a list of predicted status descriptions for the user to choose from. The status messages are combinations of a user's place, activity and mood and are predicted based on current sensor readings and the user's history of status entries (see figure 3). Additionally when the system independently thinks that the context has changed or after a period of inactivity (two hours by default), it will remind users to update their status. The goal is to allow users the freedom to richly express their current context without requiring more than a couple of mouse clicks in the best case [20]. The selected status entry is then broadcast to a wide variety of social media and Nomatic*Viz .

Nomatic*Viz

Gaver, *et.al.* argue that in certain situations ambiguity can be a valuable technique for evocative information designs [9].

Rather than focussing on minute detail, ambiguity has the potential to be intriguing, mysterious, and delightful. By compelling users to interpret representations for themselves, ambiguity can engage users in establishing more meaningful, deeper and more personal experiences with the system and with themselves. This is in contrast with traditional concerns of precision and clarity in system design. It is especially relevant for systems that move beyond work settings, weave into the rich texture of everyday lives and become culturally embedded, and where the focus is not on clear task-oriented purposes. Nomatic*Viz was designed along these lines. However, our goal was not to engage viewers with the system but rather to engage them with the data which in turn engages them with the community who is generating the data. By showing status information in an ambiguous way, we hope, it will encourage users to relate their contextual social background to more actively interpret the display and experience the community in new ways.

Its specific design was developed through a user-centered iterative design process. Previous iterations of the design demonstrated that the ambiguous approach was effective in addressing privacy issues, and in engaging users more deeply when they were also more actively participating in the community. Figure 4 shows a screenshot of the result. All participants' status data for the current week is aggregated on the display. On the top, a calendar-like bar indicates to viewers what days' data is currently being shown, the current time of the day is shown with a red arc, and a series of color boxes represents each participant whose data is on the display.

Across the display colorful "fans" are shown. Each is generated when a user reports status from a particular WiFi access point. Each user has a slightly different color. The arc sweep on the fan corresponds to the time at which the user was at the location mirroring the clock at the top of the screen. Multiple reports from that access point are layered on top of each other. A text label with the most recently reported place name is shown next to the fan. The fan is placed on the display based on the day of the week in which the data was collected. If multiple WiFi access points share the same SSID label (for example many access points administratively managed by the same organization), they are clustered together on a gray ring. The size of the gray ring is determined by the number of unique access points associated with it and it's position on the screen is based on the recency of the last status report from it. In the case of figure 4, the central ring represents a university campus. The WiFi access points detected by this community are positioned along the grey ring with place names next to them. Overlaid across the display, large lines of texts representing current activities sampled from all participants appear and disappear. The visualization highlights current real-time status reports with pulsing circles over the relevant fan.

Thus, the information presented in Nomatic*Viz is ambiguous at several levels: Instead of using a literal geographical map as its layout, it is dynamically constructed by users' collective interactions with the WiFi infrastructure. Instead of using icons to represent people, it uses different colors

Figure 4. The Nomatic*Viz display. Real-time activity statuses are shown as big words on the display that dynamically fade in and out. Colors, associated with individuals, are used to draw arcs which represent the length of time and time of day that a status message was broadcast (in the way an hour hand would sweep across a clock). A new sweep is created for every unique WiFi access point from which a user reported status. Multiple historical traces are layered on top of each other. Real-time information is identified with animated pulsing circles to draw attention to people's current status information. The display only shows data for the current week.

to subtly distinguish individuals. The mapping of colors to individuals is not specified, and is therefore unknown unless viewers have a knowledge of the community. The mapping of activity text to an individual is not made by the display. The fact that place descriptions are user generated allow for user control over the degree of accuracy over the location names. Finally, by layering historical traces of people's whereabouts over time, details become obscured but frequency becomes more pronounced.

THE STUDY

To understand how Nomatic*Viz impacted social behavior around status broadcasting, we deployed the display in a shared public space of the authors' academic department and conducted a five month field study. We focused in particular on the differences of status sharing between Nomatic*Viz and other social media, since our infrastructure was designed to broadcast the same status messages to participants' IM status fields.

The Setting

To make the display more accessible and to facilitate sharing by the whole community, we placed the display at the entrance lobby to the floor, which was also the connecting point between two wings of offices and is close to many shared resources such as the kitchen, the bathrooms, the copy and mail rooms, etc. Notably, this was not the first spot that we tried. In early iterations of this system the display had been

deployed in the elevator waiting area, where, counterintuitively, we found people didn't have time to view the display. The studied display location instead had long sight lines which enabled the display to be viewed while people were in transit to other locations.

The display of the new visualization was mounted in the lobby the end of March 2008 and remains in place as of the publication of this paper. The initial set of 7 participants consisted of affiliated researchers (one faculty member, four graduate students, and two undergraduate students). Over the next 10 weeks several other faculty members and graduate students were enrolled through personal invitations. During the summer quarter a new round of participants were recruited to replace participants who were no longer physically located in the building. Upon the time of this paper, there were 89 local users of Nomatic, 16 of which had opted-in to the display of their data on Nomatic*Viz. The 16 participants consisted of 3 faculty members, 1 research scientist, 10 graduate students and 2 undergraduate students.

Methodology
After the display was deployed in the field for five months, we conducted semi-structured interviews and analyzed logs of status messages. The interview protocol covered four areas: *everyday schedules and mobile practices*; *interpretation of the visualization*; *encounters with the display* – probing for specific instances; and *disclosure practices*. Interviews were recorded and later transcribed. When possible, to jog memories and probe specific instances, interviews were conducted with the display shown in the background, also with the interviewer providing a printed sample of past status messages to the informants. The 7 interviews were with participants not affiliated with the Nomatic*Viz project. Of the 7 informants, 2 were faculty members, one a research scientist and 4 were graduate students. Five were females and two were males. At the time of interviews, all informants had been using the display for at least a month, with several spanning the entire 5 month deployment. In addition to the interviews, logs of status messages were analyzed to gain insight into how they were shared.

AN ANALYSIS OF STATUS MESSAGES LOGS
On weekdays the participants updated their status on average 4.5 times and on weekends 2 times per day. A pattern of updates that generally declined over the course of the week was noticeably. Over the period of 170 days (from April 1st to September 17th), a total of 10772 updates were received from the participants, with about 63 updates per day and 4 updates per day per person. Out of all of the updates 471 were unique messages.

The log results suggest that Nomatic was effective in promoting status updates. It was also consistent with findings from our interviews: our informants commented that Nomatic was lightweight, and didn't involve much work to use and therefore made contributing to Nomatic*Viz easy as well. Several informants reported that they definitely started updating their status much more. It was especially true for those who didn't update at all through other social media.

More specifically, the Nomatic window popping up periodically was effective as a reminder for them to update their statuses.

To give a flavor of what status messages were broadcast by this group, we analyzed status message logs and identified five frequently used categories:

- **Meeting Events**: Including talks, presentation, meetings.(*e.g.*, "listening to XXX' talk", "attending a Ph.D. defense")
- **Work Activities**: Activities consistent with daily work.(*e.g.*, "coding", "reviewing papers", "storyboarding")
- **Expressions of Mood**: Emotions, frustrations and reactions (*e.g.*, "WHY DOES EMAIL HATE ME???????", "punching my computer in the face", "exploding")
- **Non-work Activities**: Activities consistent daily life (*e.g.*, "cooking", "making coffee", "Watching TV", "playing games with XXX")
- **Miscellaneous**: Messages such as information, invitations, and greetings (*e.g.*, "not in an earthquack zone", "Happy birthday XXX!", "early lunch anyone?")

PERCEPTIONS AND REACTIONS
As part of the evaluation of Nomatic*Viz we conducted semi-structured interviews with 7 participants.

At the highest level, our analysis demonstrated a very sophisticated and nuanced response to the introduction of these status tools into the informants' daily practice. While a complete understanding of the details of the visual elements of the display was rarely displayed, our informants all developed deep social understandings of the implications of using the tools in various ways. In the analysis below we present our findings in terms of the affordances that our informants reflected on and the resulting social changes that they occured in response.

The Glance
A great deal of the impact of Nomatic*Viz was related to its physical setting in a lobby that is connecting two wings of offices, is adjacent to several functional rooms (e.g. kitchen, copy rooms, mail rooms, meeting rooms, etc.) and is on the path from the elevator to the rest of the floor. The Nomatic*Viz display is readily visible from many angles by people who enter the floor or walk by for a variety of purposes.

The situated context and people's practices shaped the interactive affordances of the display. In interviews, the majority of informants talked about interacting with the display by "glancing" at it. Those who described the interaction as "looking" at it also indicated that it was when they passed by, either first thing in the morning upon arrival, or when they went to the copy room, the kitchen, and other's offices during the day. Despite the presence of seating by the display only very rarely did anyone indicate that they would stop, walk up and study it.

People were already engaged in an activity when the opportunity for viewing the display presented itself. An exception

to this was mentioned by two informants who on occasion would study the display while using the adjacent kitchen to warm their lunch. Greg[3] described the typical situation clearly,

> "*I pass it in the morning when I've got my backpack and my bike ... I am not going to walk up ... what usually happens is it is on the way to the water cooler, and so when I go to the water cooler, I walk by it, or when just outside of the kitchen, I go and check it for maybe 20 seconds or 30 seconds*"S

imilarly, Frances reported checking it closely when using the kitchen and reflected that most of time when she was passing by, she was busy with other stuff, so she didn't have the energy to change her actions on the way.

Social Response: Play

As people first began to use the system and familiarize themselves with the design of the display, many were humorously struck by seeing their own status messages appearing. In fact, Frank and Gladys reported one motivation for them to glance at the display was to view their own messages. George also described it was funny seeing his own status up there, "*when I see my own status, I kind of smirk, it is just funny, to see*". Grace reported similar experiences,

> "*sometimes I laugh because I see my messages up there, like one day, I had a kind of strange message, "at work caffeinating". I put that message up before I went to go get coffee, and here I am at the elevator, it says in big letters "at work caffeinating" while I had a cup of coffee in my hand, I thought it was really funny, I was like, hey, "that is mine"*"

There were similar effects when seeing innocuous or emotional statuses from their friends. George mentioned, "*I also smirk when I see "making coffee" because I know it was Frank...*". Frank also reported: "*it is just funny to see things like complaining about some work that they have to do, or complaining that they have some trouble with Microsoft office or something*". Fiona reported this response to seeing the activity "noodling", "*noodling cracks me up anyway, because noodling in America means catching fish with your hands, but in Canada, it means just hanging out, you know, paddling around, just doing whatever, ...that was sort of funny*"

The personal humorous response of seeing status messages on the display led to expressive messages that were crafted to be humorous. As this practice is common in IM [19] it was natural to extend the practice to specially crafting messages for the physical location. We found, sometimes, people customized the status with certain audiences in mind. For example, Fiona revealed a case,

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[3]In this analysis we refer to participants by pseudonyms whose first letter indicates their role in the department: faculty names start with "F", graduate students' and research scientists' names start with "G" and undergraduates names start with "U"

> "*it must be around some paper deadlines, that I can't remember, and we were joking around and I put, I was listening some silly music ... Justin Timberlake's 'Bringing the Sexy Back', so I [make it mystatus] message, just to see whether it will show up on the display, just mess around and then Frank and Frances kept running back and forth, they were going between offices, often coming in here, and they were writing together, and so I was amused to see whether they would like run past the display and happen to notice that that was on there.*"

Temporal and Individual Aggregation

In addition to the big words, the display also more subtly conveys the sense of activity level through its graphical design in features such as "fan" density, the number and distribution of color dots, the amount of animation, etc. all of which aggregate as status messages are reported during a week. Greg reported how he perceived the visual cues in conjunction with the big words, "*just walking by, I [notice] how many blurbs you can see ... high level status messages ... the radar dots that are animated ... how many people are online ... when they've been online*". Fiona similarly gained overall impressions based on colors and other visual cues. "*so I glance from a distance [to see] if there are lots and lots of bright colors, if there are very few colors on, I would recognize that ... when the quarter ended, it was remarkable to see how much less the activity was*"

Social Response: A Different Sense of the Community

As a result of juxtaposing everyone's data together and sometimes blurring it, the display was quite expressive of the mood and an overview of what is going on within the community. Using Greg's words, "*it gives you a profile ... of what they are doing and how they feel about it*". Frank mentioned a case when the display served as a reminder of community activity,

> "*on another occasion, I knew Fiona was traveling ... I went by the display one day, I saw one of the lines was "in program committee"', that reminded me where she was, because I knew she was going to that ... I realized that oh, that's right, Fiona is going to that,.. so I IM'd her about how it was going...*"

The rapid appearance of recent activities was the most common element noticed while glancing, in Greg's words, they were helpful for "*sampling what is going on*". George reported similar experiences, "*so when I walk off the elevator, the only thing that I glance at as I walk by are the big things that come up, like the task that people are doing*". To Fiona, these big words are her favorite feature, "*the number one thing I look at it, which I really like it are the big things that pop by...ambient knowledge about what is going on with my community of people*"".

Many people reported specific times when the sense of community was more meaningful to them. Fiona mentioned appreciating the sense of community when she first arrived on the floor, "*it gives me a nice feel, ok, what is going over todayish, what probably happened the last day or so*". Gladys,

who only came to the campus two or four times a week during the quarter, reported checking the display to catch up with what happened during the time she was gone. Grace described it, "*I can just look at it now, oh, yeah, I can see that people are traveling a lot of more than during the school year*"

While individual status messages might convey information about individual presence the aggregated display illuminated a sense of community presence, particularly when the presence wasn't otherwise physically obvious. For example, when the real space was quiet, the presence through the display made a difference. Fiona reported a case, "*I came here one day, although I know no one is here, there is a little bit of activity [on Nomatic*Viz], so it still makes me feel like, OK some people working somewhere, or they are online somewhere, although they are not physically here, so I think that is how I use ... like some ambient noise*" Occasionally, the words together formed patterns which characterized particular community contexts such as the end of the quarter, during a conference or a paper deadline, etc. These visible patterns enhanced the feeling of the shared experience in the community. Fiona, being one of the longest members using the system reported several such occasions,

> "*another thing that is sort of amusing me is the patterns you will see, so towards the end of the quarter, you will see "grading" up a lot, which is often, "me", Frank and Frances simultaneously, which sort of tickles me, because you get a sense of, OK, the end of the quarter, everyone is grading, or everyone is studying a lot, which is most of undergraduate students. "*F

rances, another long term user, also noticed the differences of the variety of activities between the quarter and the summer which was consistent with people's report that their schedules were more complex during the quarter.

However, whether it represents a community or more personal relationships also depends on the number of participants involved. Fiona reported a case that was revealing,

> "*when it was just, for a while, in the early summer, where it is like me, Frank, Frances, that seems about the only people that were there ...it is sort of interesting, when I go by, I would always know that is going to be one of us... then when there are more people, it is nice, it just changes the way that I see it, it just gives me more of the gestalt view of the department, but it is less like personal small group interaction*"

Ambiguity in Design

The display is designed to be ambiguous in several ways. It is anonymous in the sense that no explicit association of people's names or photos are made with the messages and the visual cues. Although location information is conveyed, it is not shown geographically. Many of the visual representations when first encountered are completely abstract and are difficult to interpret without experiencing the system. As a result it is not straightforward for many people to know

what is presented in the display. Our participants were given an overview of the visual elements when they enrolled in the study and Greg commented "*before the explanation, it was nonsensical, I knew it was some sort of status messages, that's pretty much it,*"

Social Response: A Sense of Limited Privacy

As expected, when asked about how much they can interpret about individual users, most of them can only be certain about part of it. With a portion, they can guess, but with rest, they have no idea. The following description from Frank was typical:

> "*I would say the biggest thing that is not clear in the display is sometimes I can't tell the person that is generating the data, so like the red one at the bottom right, I know that is Ulysses at home ... hacking, but I look at that sheraton hotel [status] and I wonder "who is that?" [Regarding] the "at home", I assume that is someone I work with, but I don't know which home is which home, I know "the coding at CalIT2", I know that is Uriah, I guess that is who they are but I don't know specifically. I would say I probably know for sure [who is generating the data] about 30 percent or so, probably another 30 percent I have a good guess, but for the final percent 40 percent, I have no idea.*"

It is not surprising that the display was often described as "mysterious" by the informants. Some found the mystery to be delightful, especially for people who were engaged in the community enough to be able to decode most of it, but at the same it seemed too private for others. For example, Grace thought it was a bit too private for her to make full usage of it "*maybe its not so informative, I think it is good that you try to protect people's privacy, but it is so private. It might be cool to learn about people that I don't know so well*"

While, on the other hand participation in the community coupled with historical traces tended to reduce privacy among community members. Greg elaborated on how this could be more of an issue, "*I saw [my status message] on the display, and said wow that is a personally identifying message, if you know me and what I've been up to, you can tell. Further you can tell what I am doing and when I am doing it, you can see 11 o'clock and I am still working on the damn paper*"

Ambiguity as a User Control

The display is not just expressive or descriptive, but also performative, in the sense that people actively crafted their status disclosure with an awareness of the display and potential audiences. Performative use was possible because Nomatic is only semi-automatic. While it suggests statuses through machine learning, it is up to users to decide what messages to choose, how specific the message are, and when to override the suggestions. Users have enough control to be able to negotiate what to disclose and how to disclose it. In this way ambiguity isn't just part of the design, but the level of ambiguity was also a result of user negotiaiton for what to communicate. For example, Frances mentioned that she liked to make her messages make sense to the audience, so

when she traveled, she used the hotel name, instead of the city name as her location status, because to her, that was more indicative of being in a conference.

Social Response: A Sophisticated Control of Self-Presentation
Because we evaluated this display over the course of several months, participants had the opportunity to move past the novelty of the system and began to utilize it to truly manage their status. In many cases this caused some stress as people became concerned about perceptions of their behavior made without being able to provide adequate explanation. For Greg, after repeatedly seeing his own status message on the display and especially after noticing the persistence of the data reporting that he was at different places, began to become more concerned with how people interpreted his location data. This called for a new strategy, "*[after that] I was hesitant to use an interesting message, my strategy is to make it less exciting and less funny, more vague*". When Frances went on vacation she was more concerned about reporting inaccurate information due to inattention than she was about communicating the fact that she was on vacation through the system. As a result she shutdown Nomatic .

A few informants indicated the reverse process. Out of a concern that their information was not informative enough they began to provide more details about their current activities, "*I was very surprised to see other people sharing very detailed status information about what they were doing, so then I started sharing a little bit more status information*".

Several cases were reported of people being concerned about the sensitive nature of their situation and of reporting information that was inappropriate. In these cases ambiguity was fully leveraged by the informants. For example, for some meetings with sensitive subjects, instead of disclosing what the meeting was about, people just put "meeting". Frank mentioned occasions when he felt the need to avoid giving the wrong impression about his current task. He reported, "*there are times I would rather not let them know about the details of what I am working on. Like maybe I have responsibilities to deliver something to them, I don't want to bring it to their attention that I am not working on that right now, although I have plenty of time scheduled to work on it before it is due.*" Grace was worried about the explanations that would need to accompany very explicit information: "*there was one week I was sick, I was at home all the time, I kind of didn't want everyone to know that I was at home all the time, so I didn't put out things into Nomatic* ".

Because of the ambiguous nature of some status messages, people often sought to ascertain the source or clarify the meaning of the messages. This was typically accomplished by pursuing face to face encounters or by going back to IM to observe the same status message on a buddy list. The expectation of this behavior led some people to craft messages in such as way as to invite or repel social contact.

Fiona reported reacting to status messages as a barometer for social contact: "*I used it as a lightweight [availability signal], as I walk by anyway I check his status on Nomatic*Viz ,*

then I can think in my head what I should do next...[if she noticed that Frank was "in his office"] I would just go straight to his office, not sit at my desk and open my computer." on another occasion,

"*so I came in several times during that week before the grant was due, if I saw "noodling" in the visualization, I knew that probably she wasn't working, if I saw "writing", then I would go to my office and IM her about how things are going, and she and I were just checking out with each other, because both of us were writing for the grant*"

Other times, people used more specific message to provide status but suggest that social contact was not welcome, Grace reported, "*sometimes, I am working pretty intensively on something, like, this week, I was working on a NSF grant, and I put it as "I am busy with NSF grant", then [only people who are] working with me on the NSF grant, know that they can disturb me because they were also working on the same thing ... sometimes that is helpful in terms of being a gate keeper.*"

DISCUSSION
Through it's community-aggregated status, ambiguous representations, physical and social setting, Nomatic*Viz is quite different from most popular social media in a number of ways: Most are built on an ego-centric model in which the self is centrally-oriented. This display, however, makes the community the central focus by conveying an overview of many individuals using techniques of aggregation and blurring. As a consequence, the display provides an opportunity for users to see their own and others' status from a third-party view, and invites reflections upon the effects of their status disclosure juxtaposed against their community's. This, in turn, causes more active negotiations of what and how to construct and share status messages. While negotiation of self representation is probably present in all status broadcasting media, seeing a more objective display may enforce this process.

Our experience validate our ambiguous design approach. In terms of privacy, people felt Nomatic*Viz was more anonymous than IM, and were less concerned with sharing more specific and personal messages, although its persistent nature had some of the reverse effects. People with different levels of engagement with the community also had different attitudes towards the ambiguous nature. While some thought it was too private to be informative, others who could more easily interpret it found it mysterious and fun. Moreover, besides natural revealing of message authors based on their use of the space, interactions with each other, and use of IM, people also engaged in active social interactions to interpret the display.

Ambiguity was not just part of the design, but also a tool for users' negotiations of self-representations. The study revealed that, far from disclosing their status passively, our informants all demonstrated sophisticated negotiaiton processes between revealing more general or revealing more

specific statuses based on the awareness of the audience and the sensitivity of the context. Many factors cause users to use more ambiguous and general messages such as the persistence of the display or unknown audiences, however, the display was also appropriated by our informants to communicate messages to the community. With carefully crafted messages, participants invited certain social contact and repelled others across all the media to which the status was broadcast.

We started the investigation by assuming the messages on the large displays were more public than IM. While IM contains buddy lists of our personal relationships, the large displays could be seen by anyone, visitors and strangers coming to the building. However, our study suggests that "public" and "private" might not be the best concepts to understand these displays and their use. Some informants, especially faculty, revealed that their buddy list had become very mixed audiences themselves. The large display suggests certain kinds of audiences, the people who use the building, which actually might be more private. Our experiences with Nomatic*Viz display suggest that ideas of different audiences are more useful organizing concepts than public vs. private.

While Nomatic*Viz is open to strangers and visitors, it is more anonymous and has no identifiable sign of individuals. While IM is for one's own social networks, it has clearer individual accountability. However, the co-existence of both displays encouraged reflections on the effects of the status to the different audiences they provide. For example, some of our informants adapted the display for sending greetings to someone such as "Happy Birthday", and it caused them to reflect on the differences and level of appropriateness for broadcasting the same message to both Nomatic*Viz and IM, especially when the birthday person was only in one of the broadcast audiences.

Sometimes the two different displayse seemed to reinforce each other (*e.g.*, IM helps users to interpret the display and the display triggers users to check IM status). However, other times, the co-existence of both caused some difficult tension. As a result, over time, our participants tended to act conservatively in dealing with the two displays, by using more ambiguous and general status messages and leaving the details to be resolved through direct communication.

CONCLUSIONS

In this paper, we have presented Nomatic*Viz, a large public display showing people's location and activity status in a shared community space based on Nomatic - a context-aware tool used for status updates and distribution. The visual design of the display employed an ambiguous representational approach to conveying status as means of encouraging reflective, engaging and appropriate status sharing system for an "offline" community. Through a five month field trial of Nomatic*Viz in a academic department settings, we exposed users' interactions and experiences with the display as well as their status disclosure practices.

Finally, Our study revealed that people's experiences with

the display were clearly shaped by the physical and social characteristics of the setting, the status content, as well as the social relationships contained in it (*e.g.*, recognizing a friend's status). At the same time, people also negotiated the meaning and the use of the display over time and incorporated the display and status broadcasting into their daily lives. The content of the display was not just passively released by this group, but was actively and sophisticatedly crafted with an awareness of the audiences. These skills were developed through social play and experimentation over a period of time.

REFERENCES

1. L. Barkhuus, B. Brown, M. Bell, S. Sherwood, M. Hall, and M. Chalmers. From awareness to repartee: sharing location within social groups. In *CHI '08: Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems*, pages 497–506, New York, NY, USA, April 2008. ACM.

2. S. A. Bly, S. R. Harrison, and S. Irwin. Media spaces: bringing people together in a video, audio, and computing environment. *Commun. ACM*, 36(1):28–46, 1993.

3. B. A. T. Brown, A. S. Taylor, S. Izadi, A. Sellen, J. Kaye, and R. Eardley. Locating family values: A field trial of the whereabouts clock. In J. Krumm, G. D. Abowd, A. Seneviratne, and T. Strang, editors, *Ubicomp*, volume 4717 of *Lecture Notes in Computer Science*, pages 354–371. Springer, 2007.

4. E. F. Churchill, L. Nelson, L. Denoue, and A. Girgensohn. The plasma poster network: Posting multimedia content in public places. In M. Rauterberg, M. Menozzi, and J. Wesson, editors, *INTERACT*. IOS Press, 2003.

5. G. Cockton and P. Korhonen, editors. *Proceedings of the 2003 Conference on Human Factors in Computing Systems, CHI 2003, Ft. Lauderdale, Florida, USA, April 5-10, 2003*. ACM, 2003.

6. A. Crabtree and T. Rodden. Hybrid ecologies: understanding cooperative interaction in emerging physical-digital environments. *Personal and Ubiquitous Computing*, January 2007.

7. P. Dourish and S. Bly. Portholes: supporting awareness in a distributed work group. In *CHI '92: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 541–547, New York, NY, USA, 1992. ACM Press.

8. G. Fitzpatrick. *Locales Framework: Understanding and Designing for Wicked Problems*. Kluwer Academic Publishers, Norwell, MA, USA, 2003.

9. W. W. Gaver, J. Beaver, and S. Benford. Ambiguity as a resource for design. In Cockton and Korhonen [5], pages 233–240.

10. S. Greenberg and M. Rounding. The notification collage: posting information to public and personal displays. In *CHI '01: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 514–521, New York, NY, USA, 2001. ACM.

11. J. Horrigan. Mobile access to data and information. Data Memo 202-419-4500, Pew Internet And American Life Project, 1615 L Street NW, Washington D.C. 20036, March 2008.

12. G. Hsieh, K. P. Tang, W. Y. Low, and J. I. Hong. Field deployment of IMBuddy : A study of privacy control and feedback mechanisms for contextual im. In McCarthy et al. [17], pages 91–108.

13. E. M. Huang and E. D. Mynatt. Semi-public displays for small, co-located groups. In *CHI '03: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 49–56, New York, NY, USA, 2003. ACM.

14. E. M. Huang, D. M. Russell, and A. E. Sue. IM here: public instant messaging on large, shared displays for workgroup interactions. In E. Dykstra-Erickson and M. Tscheligi, editors, *Proceedings of the 2004 Conference on Human Factors in Computing Systems, CHI 2004, Vienna, Austria, April 24 - 29, 2004*, pages 279–286. ACM, 2004.

15. S. E. Hudson, J. Fogarty, C. G. Atkeson, D. Avrahami, J. Forlizzi, S. B. Kiesler, J. C. Lee, and J. Yang. Predicting human interruptibility with sensors: a wizard of oz feasibility study. In Cockton and Korhonen [5], pages 257–264.

16. N. Marmasse, C. Schmandt, and D. Spectre. Watchme: Communication and awareness between members of a closely-knit group. In N. Davies, E. D. Mynatt, and I. Siio, editors, *Ubicomp*, volume 3205 of *Lecture Notes in Computer Science*, pages 214–231. Springer, October 2004.

17. J. McCarthy, J. Scott, and W. Woo, editors. *UbiComp 2008: Ubiquitous Computing, 10th International Conference, Seoul, Korea, September 21-24, 2008*, New York, NY, USA, September 2008. ACM.

18. T. P. Moran, E. Saund, W. V. Melle, A. U. Gujar, K. P. Fishkin, and B. L. Harrison. Design and technology for collaborage: collaborative collages of information on physical walls. In *UIST '99: Proceedings of the 12th annual ACM symposium on User interface software and technology*, pages 197–206, New York, NY, USA, 1999. ACM.

19. D. J. Patterson, C. Baker, X. Ding, S. Kaufman, K. Liu, and A. Zaldivar. Online everywhere: Evolving mobile instant messaging practices. In McCarthy et al. [17], pages 64–73.

20. D. J. Patterson, X. Ding, and N. Noack. Nomatic: Location by, for, and of crowds. In M. Hazas, J. Krumm, and T. Strang, editors, *Location- and Context-Awareness, Second International Workshop, LoCA 2006, Dublin, Ireland, May 10-11, 2006, Proceedings*, volume 3987 of *Lecture Notes in Computer Science*, pages 186–203. Springer, 2006.

21. P. Sengers, K. Boehner, S. David, and J. J. Kaye. Reflective design. In *CC '05: Proceedings of the 4th decennial conference on Critical computing*, pages 49–58, New York, NY, USA, 2005. ACM.

22. I. E. Smith, S. Consolvo, A. LaMarca, J. Hightower, J. Scott, T. Sohn, J. Hughes, G. Iachello, and G. D. Abowd. Social disclosure of place: From location technology to communication practices. In H.-W. Gellersen, R. Want, and A. Schmidt, editors, *Pervasive*, volume 3468 of *Lecture Notes in Computer Science*, pages 134–151. Springer, May 2005.

23. J. C. Tang, N. Yankelovich, J. Begole, M. V. Kleek, F. Li, and J. Bhalodia. Connexus to awarenex: extending awareness to mobile users. In *CHI '01: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 221–228, New York, NY, USA, 2001. ACM Press.

24. K. Thompson and D. M. Ritchie. *Unix Programmer's Manual*. Bell Labs, November 1971.

25. R. Want, A. Hopper, V. Falco, and J. Gibbons. The active badge location system. *ACM Transactions on Information Systems*, 10(1):91–102, 1992.