Information Art Based on Community Activity in a Large Workplace

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Abstract

One of the challenges of building a sense of community within a large workplace building is due to people's lack of awareness of the people outside their immediate work areas. LAVAlamp is an information display which addresses this problem: it is an abstract visualisation of the people in a building. This paper describes its design, its implementation in terms of the pervasive infrastructure and user interface. We report a qualitative user study with 6 people to assess its utility for supporting awareness of building activity, its perceived value and appeal as well as people's views about privacy. Overall, participants found it an attractive ambient appliance, they could understand it and valued its depiction of the people in a building and considered its design addressed privacy concerns.

1. Introduction

Social awareness within a large workplace building is important but can be hard to achieve. People working in large buildings can be unaware of activities in other parts of the building and particularly, can fail to know what others are doing or where people are gathered. This can lead to a sense of disconnectedness from the workplace community. This can be particularly true of new employees or visitors to the workplace who may be unaware of some of the social patterns that exist.

LAVAlamp addresses this problem. It presents an abstract visual representation of the coarse-grained locations of the building’s occupants as well as other anonymised information related to their activity. The system is designed to be displayed on a screen or projector in common areas of the building, or simply on a user’s monitor. It is intended to unobtrusively inform the user of the human activity within the workplace in real-time, whilst being pleasing to watch and complementing its surrounding environment.

In this paper, we first review work related to information displays for community awareness, then describe the design of LAVAlamp from a user’s perspective and from a technical and aesthetic perspective. In the next section we describe the implementation of LAVAlamp. After this we present a qualitative user evaluation of the system. Finally, we conclude on the strengths of LAVAlamp and future work.

2. Related Work

Reflecting the emerging recognition of the potential value of visualisations and the importance of social awareness, there has been a growing body of work integrating data visualisation and physical environments.

Redstrom et. al. [5] state that information art is the focus on “how traditional art objects, like paintings and posters, can be augmented, or amplified, and made to display information”. They identify that there should be a mapping between the design structure of the artwork and the information communicated such that rather than being an exact depiction of the information, the art is abstracted and aesthetic. They then explore effective methods to achieve this mapping including the alteration of properties like size, shape and colour, as well as the use of generative grammars. They believe that the purpose of the artwork is to be aesthetically pleasing while increasing awareness about otherwise hidden information from the physical environment around them. In contrast to ambient displays which are designed to communicate information completely in the periphery of the user, information artwork is designed to be interesting and allow the user to concentrate on them for moments of mental rest, as is the case with traditional artwork. At the same time it should be unobtrusive and not force the user to pay attention. We set about creating an information display to increase awareness of occupants in a building.

Ambient displays, as described by Wisneki et. al. [2], “present information within a space through subtle changes in light, sound and movement, which can be processed in the background of awareness”. The
concept is that parts of the environment surrounding a user would change in a way that does not distract the user but nonetheless communicates information to them. This can manifest itself, for example, as a piece of artwork, such as a painting that subtly changes, as in [6].

More generally, peripheral displays, as described by McCarthy et. al. [7], are visual displays distributed throughout physical space to supplement those used for primary work activities. These displays do not necessarily have an emphasis on being aesthetic and can more accurately communicate information. In a number of instances, they have been used in order to attempt to increase social awareness in the workplace. The GroupCast [7] application, for example, uses a public display to deliver content that is of mutual interest to users nearby with the aim of sparking conversation between them and furthering the development of relationships. Other peripheral displays with similar objectives have also been developed and tested with some success, as in [4].

Dourish and Bly [3] state that awareness, in the social sense, “involves knowing who is ‘around’, what activities are occurring, who is talking with whom”. They state that awareness may lead to informal interactions, spontaneous connections and the development of shared cultures. Large workplaces can hinder this social awareness, particularly if poorly designed. For example, those within the workplace may be large physical distances apart and hence not know what is happening in the other side of the office. This is the problem that LAVAlamp attempts to solve.

Izadi et. al. [1] also explored the notion of increasing awareness using location information in a family situation. The “Whereabouts Clock” is a device which is placed in a family home and the coarse-grained location of members of the family are displayed on it (home, work, school or elsewhere). The location information is detected by mobile phones being carried by users. In their user study, Izadi et. al. found that the clock brought a stronger sense of connection between members of the family. It increased the feeling of safety about family members and evoked feelings of connectedness and togetherness. This increased awareness about people around oneself through knowledge of their location is also what LAVAlamp attempts to achieve, however in a workplace environment, rather than a family one.

2. Design

![Figure 1: Typical screenshot taken from LAVAlamp at 1:32pm, 4th December 2007.](image-url)
We first describe LAVAlamp from a user’s perspective. Figure 1 shows a screenshot of the visualisation during normal operation. Each shape on the screen represents a person detected within the building. The colour of the shape (which can’t be seen in the greyscale image) denotes the coarse-grained location of the person. In the context of this system, this correlates to which floor of the building the user was detected on.

The size of a shape denotes how long a person has been within the building. A square denotes a person who is at their desk or in their office, and a circle denotes a person who is mobile.

The shapes float around the screen with a velocity dependent on the total number of people in the building, i.e. the more people there are in the building, the faster the shapes move around.

As new people enter the building, new shapes are created in real-time; as they change location, their colour also changes; and the longer the person stays in the building, the larger their shape becomes. If they have not been detected in the building for a given amount of time (3 hours in this case), they will float to the top of the screen, where they will remain still for a period before disappearing.

It is important, now, to make a distinction between two types of people displayed on the system. The larger shapes on the screen are people who have registered with the underlying location-tracking system [9] and have chosen to have their data displayed. Their presence in the building, location, time spent in the building and whether or not they are at their desk are all shown in the display.

Other people, who have not registered with the system, but have still been detected in the building, are represented by the small “bubbles” on the display. Only their presence within the building (and how that was gathered) are shown on the display. The reason for this is that the data about these people is less accurate and also may present privacy concerns if more information about them was shown without their knowledge.

The graph on the right-hand side of the display indicates how many people have been in the building over the past 24 hours, with the newest data at the top. The bottom left has a display of the current time and date.

2.1. Design Objectives

LAVAlamp had two main objectives:

1. Increase the viewer’s awareness of the amount of activity in the surrounding workplace.
2. Be aesthetically pleasing to watch.

The following sections we describe the approach we have taken to achieve these goals.

2.2. Increasing Workplace Awareness

Awareness, as mentioned in the related work, is a broad concept that involves knowing about one’s surroundings. As such, different elements of one’s awareness can be increased in different ways. For example, Huang et. al. [4] use a peripheral display which shows user-submitted “awareness items”. These articles might, for example, describe a project that is currently underway in the workplace. In this way, they attempt to increase awareness of co-workers’ current activities.

Information about the location of people can also be used to increase awareness as Izadi et. al. [1] demonstrated with the Whereabouts Clock. We extend this concept which was intended for a home setting into the workplace. Knowing the location of colleagues in the building, even if this information is anonymised, can help to increase a sense of community or connectedness. It can help people to determine where important events are occurring or social hot-spots and hence help develop relationships between people, particularly for those unfamiliar to the workplace. It can also prompt people to ask questions about behaviour they observe, leading to a better understanding of the social dynamics of a workplace. Simply knowing that people are around can help to reinforce a feeling of togetherness.

Participants who have some knowledge of the system can use the data it presents to infer even more about activity in the building. For example, if many people seem to be on Level 1 (where the tea-room is) at 10am, then a user might infer they have gone to have a coffee. This can enhance the usefulness of the system and increase awareness to an even greater extent.
Retrospective data that is expressed through the graph on the side and the floating to the top of undetected people aim to further inform a user of how activity now compares to activity in the recent past, further increasing awareness of the social activity in the workplace.

2.3. Aesthetic Design

We chose to visualise the location data abstractly. There were a number of reasons for this. First, the data available about people’s locations was not fine-grained enough to produce a display that gave a more statistical representation. Such a representation may have also presented greater privacy concerns than the current system.

Secondly, an abstract representation allowed for a greater flexibility in making the display visually appealing [8]. There are many options when considering such a display in relation to how abstract the representation is and the attention required by users to absorb the data, as discussed in the related work. We chose to produce a display that we think is best classified as informative art. It aims to be aesthetic, just as a traditional piece of art is, but also to convey information in a way that can be understood by appropriately examining it. LAVAlamp attempts to allow users to get a different understanding of the display depending on whether they quickly glance at it or spend more time attending to it. Our aesthetic goal is that LAVAlamp not only complements the environment it is placed in but also increases interest in the information conveyed, so increasing its effectiveness.

The key concept for the display comes from the model for gas molecules moving in a container. As the gas heats up, the molecules move around faster. In LAVAlamp each person is represented by a circle or a square floating around the screen. As more people enter the building (more building activity) the speed at which these shapes move also increases, giving a sense of busyness to the display.

All visual aspects of the display are aimed at being calming. This includes the flowing motion of the shapes around the screen, the cool colours chosen, the use of transparency, the smooth transitions of colour and shape and the smooth graph on the side. The aesthetic design of LAVAlamp is intentionally simple to help aid viewers in understanding the display. The graph on the side of the display which depicts activity in the past 24 hours is also aimed at being aesthetic, trading some accuracy to be smooth.

3. Implementation

LAVAlamp is built upon a modified version of a system called MyPlace Locator [9]. MyPlace Locator collects data about the locations of people from Bluetooth sensors and sensors on computers. It uses an underlying framework called PersonisAD [10] which provides a mechanism for the modelling of people, sensors, devices and places for ubiquitous applications. Data about people’s locations is added to their models (as evidence) and a resolution process is used to determine their current location. Resolution involves examining recent pieces of evidence to determine which evidence is most likely to be true. MyPlace Locator also provides an interface for viewing location information about the people, places and devices around a person and controlling how their information is used.

PersonisAD uses a Berkley DB database to store data which has been shown to be sufficiently fast for most applications using the PersonisAD framework. LAVAlamp, however, can require a large amount of retrospective data if it is used to replay through a long period of time. While we still use a number of the mechanisms built into MyPlace Locator, we use a MySQL database for faster retrieval of the data. This also allows data that is not associated with a registered user of the system (anonymous users) to be used.

The system currently collects location data from Bluetooth sensors, which can detect any Bluetooth device, such as a mobile phone, and system sensors which detect activity on a computer. If a user is registered with the system then these devices will be stored in the user’s model and so we can fairly reliably use data collected to reason about their location. If Bluetooth or system sensor data is collected about someone who is not in the system, it is used to represent anonymous people. As such, this data is less reliable. For example, a Bluetooth device may be attached to a computer somewhere and not accurately represent a person in the building. Similarly, a person not registered in the system who logs into a computer and is detected may also have a Bluetooth device and so appear twice on the display.

3.1. Application Design

LAVAlamp has been designed for flexibility. For this reason, the back-end of the system has been written as a server-side CGI script (in Python) which interfaces with the MySQL database and Personis and outputs results in XML format. This allows a wide variety of front-ends to be developed. We chose to develop the front-end visualisation as a Java applet.
3.2. Back-End

The back-end CGI script, written in Python, interfaces with the MySQL database and MyPlace Locator framework. It pulls location information out of the database and applies a resolver to it to determine the most likely location of each person. We use a simple office-bias resolver which will mark a user as in their office if any recent evidence (evidence within the last 15 minutes) shows them to be there.

The script can take 3 parameters: a start time, a stop time and a step period, which allow complete and convenient access to data from any time in history. These are all time values, measured in seconds. The start time is how many seconds ago to start retrieving location data. The stop time is how many seconds ago to stop retrieving location data. For example, if the start time is 10 seconds and stop time is 2 minutes, data between 10 seconds ago and 2 minutes ago will be retrieved. The step period determines the intervals at which to collect data; for example, if the step period is 10 seconds and the start time is 10 seconds, the script will extract data from points at 10 seconds ago, 20 seconds ago, etc. This is so that the time-granularity of data can be controlled and if one only wants a few data points in a period of time, say every hour, they can be efficiently extracted.

Output is in XML format. The XML is structured as a series of points in time with each point corresponding to an interval dependent on the arguments given. Each point contains a list of users detected at that point in time and their location. Hence, the XML has the form:

```
<point time="12345">
    <user id="personA" location="level1" />
    <user id="personB" location="level2" />
</point>
<point time="12346">
    <user id="personA" location="level3" />
    <user id="personB" location="level2" />
    <user id="personC" location="level1" />
</point>
```

Most often, only the most recent point in time is requested. Older data, however, can still be accessed if the display is to be replayed over a period of time.

The script also provides a very basic time-synchronisation facility to ensure that the front-end is kept at roughly the same time as the server storing the location information.

3.3. Front-End

The front-end of LAVAlamp is written as a Java applet for portability and to allow delivery over a network. The Processing [11] library was used to ease development.

The applet queries location data from the back-end script and caches it for later use. For example, one could query data from the past 24 hours and then play through that data on the display. The applet also queries the most recent data available at set intervals in time to allow for real-time playback.

4. Evaluation

4.1. Evaluation Design

The key objectives of the user evaluation were:
1. To determine how effective the display is in communicating information to users.
2. To determine how intuitive the display is to a user who has no prior experience with or information about the system.
3. To determine whether or not users find the display visually appealing.
4. To determine whether or not users are interested in the information provided by the display.
5. To explore ways in which the display could be improved.
6. To identify any privacy issues.

The evaluation was designed as a combination of think-aloud use of the system and a series of questions about the participant’s understanding of, and response to it. This design provided the qualitative results that were needed to meet our goals.

Six participants were recruited from regular users of the School of IT building. This ensured that they matched the main target population, the community for whom the information is intended. Participants had no prior experience with, or information about, the system. This ensured that their initial response was that of a first time user.

The experiment began with participants being invited to explore the interface. They were provided with no information about its meaning. They were observed during this think-aloud phase, with the experimenter noting the participant’s actions and comments. Participants were then asked to write a free form comment on what they thought the display was showing.

Then they were asked to rate how aesthetically pleasing they considered it as an ambient display in a building. Responses were a Likert scale from 1 (poor) to 6 (attractive). Then they were asked if they would
like to see such a display in the building foyer, and to explain their answer. This phase informed Objectives 1 - 4, for the case where the user has no information about the display.

For the next step, participants were told that the acronym, LAVA, in the title of the display stood for Location Aware Visualisation Application and then asked to comment again about the meaning of the display. At this stage, participants were explicitly asked what they considered was represented by each of the main elements, described above in Section 2 and then to consider the historic display at different times of the day and its meaning. This phase informed Objectives 1 and 2.

For the third step, participants were provided with the full key, as it appears at the lower right of Figure 1. They were asked exactly the same questions as in Stage 1. This phase informed Objectives 1 - 3, for the case where the basic description was available, as we envisage it would be for an installation in a public area of a building.

This concluded the think-aloud phase where participants studied the display. They were asked how they would use the display, informing Objectives 1 - 4. The next questions asked for suggested improvements, both in terms of information and aesthetics, primarily informing Objective 5. Finally, we asked participants to comment on how they felt about the privacy the system offers, both in the case of registered users and others. This informs Objective 6.

After the main experiment, participants completed a demographic questionnaire, asking their gender, age, position in the University (staff, student, other as specified), length of use of the IT Building, frequency of use of it and familiarity with our Locator system [9].

The questionnaire was at the end of the experiment to avoid the possibility that participants’ main experimental result might be prejudiced by their having answered these questions before using the system. Pure demographic questions were to ensure that we would be aware of the profile of the participant population. Given the goals of the study, we did not plan to analyse the results against this data. The questions about building use were important for assessing the extent to which they were a part of the building community: we would expect that more frequent and long term users would have a stronger identification with the building community. The final question, about use of Locator, was to take account of the fact that the underlying location modelling infrastructure for both systems is identical and this may have affected people’s interpretation of the display.

Of the six participants, 4 were male. Five were students, with the other being a student who also works in the building. All had used the building for at least 7 months and four for more than a year. Five participants used the building at least 5 times per week; the other 2-4 times. Three participants had heard of Locator but had never used it. Two had registered for it and use it, one of them having participated in evaluations of it. One participant had used Locator but was not registered with it.

4.2. Results

For the first question, 5 of the 6 participants correctly guessed that the display was a visualisation of people’s activity. In terms of its aesthetic appeal, the display scored an average of 4.08 out of 6 (median value of 4.25), and all users agreed that they would like to see a display like this in the building foyer.

The results for the second question were quite mixed. Without the key, most users struggled to correctly identify every component, but were generally able to guess at least one or two correctly. All of the users suspected at some point that the floating shapes represented people, and all had a good idea of how the timeline on the side operated. The timeline itself proved to be a useful clue in helping the participants guess what the rest of the display was showing. Two of the users correctly guessed the meaning behind the shape of the objects. Other features like the colour seemed to be mysterious to all users.

Participant 4, who correctly guessed almost every component, did already have some background knowledge of the Locator system, so her accuracy might be partially due to the fact that she already knew what kind of data the system collects about people, and was just looking for a way to map it onto the interface.

Another point worth noting is that while the bouncing movement of the shapes actually encodes little information, most users thought that it must be representing something important (the most common suggested was that it indicated the activity level of the person represented by the shape). Although only one user wrote it down, most of them suggested at some point that the shapes floating to the top of the screen might indicate when a person has gone home.

It is striking that with so little information, participants were able to interpret so much of the display.

After seeing the key in Question Three, most of the participants had no problem identifying the different parts of the display. Some felt that the key was slightly unclear about the unregistered users, but still 5 of them worked it out without any assistance. Two of the participants still found the bouncing movement confusing even after seeing the key.

For the fourth question, all participants were readily able to interpret temporal data from the display, and
showed a good understanding of how the display changed over the course of a day. This was highlighted with Participant 3, who noticed that a number of people arrived quite late one night and tried to remember if there had been any events on that night that could account for the change.

For Question Five (which required participants to grade the aesthetics on a scale of 1-6), the answers were identical those they gave in question 1, except for Participant 5, who changed from 4 to 5.

The results for Question Six were similar: once again all participants agreed that they would like to see a similar display in the building foyer. Two of them also noted that such a display would be contextually very appropriate within an IT building.

For Question Seven, three of the users were able to suggest ways in which the display could be useful in daily life – these ranged from determining how full computer labs are, to gauging whether or not it would be worthwhile trying to contact someone within the building. The other three couldn’t see much use for the display as an information source, but felt that it still had value as a piece of art.

Regarding possible aesthetic improvements (Question Eight), three of the users commented on the overall complexity of the display, and felt that it was trying to show too many different axes of information at once. They suggested that it might be better to simply leave out some of the information and aim for a cleaner, simpler interface. Two commented about the quality of the graphics (e.g. text wasn’t antialiased). Otherwise, the participants felt that the display as quite attractive.

In terms of the information being depicted, the main suggestions were to make the time in the bottom-left corner larger (one participant did not notice it until explicitly asked about it), use the position of the shapes to convey information instead of it being random, show finer-grain location data, and make sure that the key is clearly visible, either as part of the display or somewhere nearby.

In the final question, which deals with privacy, the participants all stated that as there are so many users in the system they did not consider privacy a concern: they noted that it is difficult to work out which shapes correspond to which users. They also felt that as the registered users have already given their consent to be shown on the display, they shouldn’t have any problem with their data being used in this way. Two participants noted that if there are only a few registered users in the building, privacy could become an issue, as it would be much easier to work out who the shapes were representing.

The participants also felt that there were no real privacy issues for unregistered users, since the data is completely anonymised, and there are generally so many unregistered users in the building that privacy is guaranteed. One participant mentioned that it might also be a good idea to give unregistered users the option of hiding themselves from the system.

While all of the participants stated that they would be quite happy to register with the system, they varied in the information they would be willing to have shown on the display. Five said that they would be happy for the display to show their current location, as well as how long they had been in the building. Three said that they would not mind their name being shown on the display, although one of them said that if his name were shown, he would want his location kept secret. One user stated that he would not want to share any additional information.

Three of the participants had no additional comments regarding the privacy of the system, but the other three stated that people should be notified that their data is being collected upon entering the building, and should also have the ability to find out how much information the system is actually collecting about them.

5. Conclusions

We have described the design of LAVAlamp, an information display which helps build community awareness. Even allowing for the potential that participants were likely to be polite, the qualitative evaluation suggests that it meets its key information and aesthetic goals, and would be suitable for use in a large workplace.

6. References


