

# Interacting With Shared Displays: A Preliminary Study of Ubiquitous Graphics

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## ABSTRACT

This paper presents results from a preliminary study of a system called Ubiquitous Graphics – a co-located collaborative system which combines the use of large and small displays. The results show that the system offers a rich interaction set for users working on a collaborative task. It provides both means for awareness, and also the ability to pull information from different workspaces by multiple means.

## Author Keywords

HCI, groupware, user study.

## ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## INTRODUCTION

In this paper we present a preliminary analysis of a user study of a co-located collaborative system for working with large images, called Ubiquitous Graphics. The aim of the study was to see the kinds of interactions that the system afforded and how users worked with it.

## SYSTEM

Ubiquitous Graphics [5] is a system which combines the use of small and large displays, to give access to both overview and detail simultaneously. The system allows a number of small handheld devices, such as PDAs or Tablet PCs, to be combined with a large display, to allow multiple users to work with large images. The large display (in our setup a back projection) provides the users with an overview of the large image (e.g. a map). The smaller devices show a high resolution image of portions of the large image. Using ultra sonic tracking, the small devices can be held up against the large display and the view on the

small display is synchronized to show the occluded area of the large display. Thus to see more details (or additional information) of something which is not visible due to the low resolution of the overview image, the user can hold the small display over area and use it as a magic lens [1]. In addition, the user has simple GUI controls on the small display which can be used to pan and zoom in and out the view of the small display. The portion of the large image which is visible on each user's small display is shown as rectangles on the large display. It is further possible to do simple annotations by writing with a stylus directly on the small device, which is propagated and displayed on all other devices in the system. Thus one user can see on the large overview display that another user has annotated something, and then see in detail what he has drawn using his smaller device. You can furthermore use your own stylus to draw on someone else's device. See Figure 1 for a photo of Ubiquitous Graphics in use.

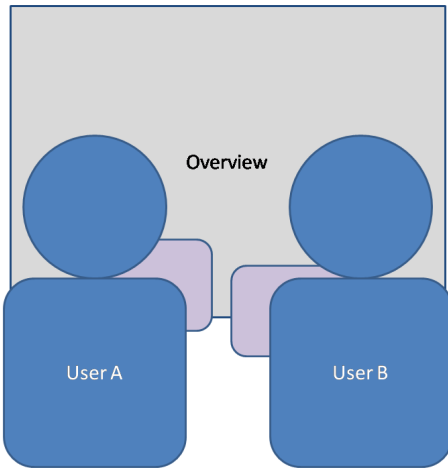


Figure 1. Ubiquitous Graphics used by two people where the person on the right is writing on the other's display while he holds it over the large display.

## STUDY

We conducted a study in which pairs of participants were asked to perform a task while we recorded their actions on video from two angles. The purpose of the study was to see

in what ways people would use the system when interacting with each other to complete a task.



**Figure 2. System setup: User A and user B standing in front of backprojected overview screen, with one personal tablet PC each.**

### Participants

The set of participants were ten pairs of two individuals. They were between 19 and 36 years of age. In four of the groups they were both male, in two groups they were both female, and four groups were mixed. All except two of the groups spoke Swedish. They were all undergraduate students at a local university, and they were recruited from their study hang-out. As a token of appreciation they received a gift certificate for the cinema.

### Setup

We asked the participants to complete a task of collaboratively scheduling one day of cultural activities which were displayed on a map. The projected overview screen showed a map of the center of the local city with activities shown as icons, where different icons meant different types of activities (art exhibition, theatre play, movie screening, club activity, etc). On their personal devices, the same map was shown, but with text boxes next to the icons describing in brief detail what the activity was all about (e.g. the text “Dead By April, Sticky Fingers, Pop/Metal, 21-04” next to a musical note, where “Dead By April” is a band name, “Sticky Fingers” the name of a rock club, and “21-04” the opening hours), as in Figure 3. Using this information they were then supposed to pick five activities to attend to during one Friday. They were asked to pick at least one art exhibition and one theatre play, and to end at a night club. They would then explain to the researchers in which order they would go to the chosen activities.

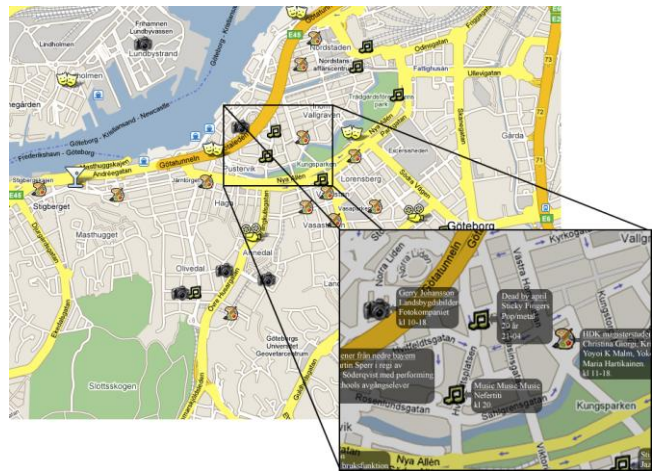
The participants were first given a short introductory presentation of the system, and then asked to try the system themselves for a few minutes. They were then given the

task details, and left alone to complete the task. The complete setup of users and displays are shown in Figure 2.

### Analysis

The sessions were filmed from two angles, which were then edited together to simplify analysis. The first view was from behind the participants and the screens (much like the sketch in Figure 2), to show both how they interacted with each other, but also what they did on the overview display. The second view was from the side and slightly in front of them. They were edited together so that the main view was from the side, and a smaller picture-in-picture at the bottom left corner showed the view from behind.

The videos were analyzed qualitatively looking at how they interacted with each other and the system to decide which activities to go to. We looked at what kind of information they used to decide their activities, but most importantly how they used their own, their partner’s, and the large, display to find, talk about, and refer to activities. The results are presented next.



**Figure 3. Overview image showing only icons, and zoomed in detailed view showing text boxes with information about the activities.**

### RESULTS

In this section we will talk about the results of our study. From this point on, as the participants worked in pairs, two participants from one pair will be referred to as X and Y, and the order of them are of no importance unless otherwise stated.

All groups completed the task in between 4 and 9 minutes. The amount of collaboration varied, where some groups hardly discussed which activities to go to more than to compromise between the choices: “I want to go to this one, do you want to go to that one?”. Others had a rich interaction with each other where they were negotiating and discussing different possibilities.

As envisioned, the participants used the system in various different ways. They used the big display to familiarize with the set of activities on a broad scale, and then used the

small displays to check the details. Some participants zoomed out with the small display to get a better overview on their own device. Some stayed zoomed out, and some actively zoomed in and out repeatedly to change from overview to details. Others barely zoomed out at all, but instead panned or held their own device over the big display to quickly change the view. They also used each others' displays, both when talking about activities but also when just looking for activities. To see what their partner was doing they looked the big display to see where their current view was, but they also glanced at the other's display. They also glanced at each others' display when discussing an activity on one screen, as well as annotated on each others' displays using their own stylus.

To contrast from when using for instance laptop computers positioned on a table connected in a setting with a shared big display on a wall, the ways for users to change something on another user's view is either by "hijacking" his keyboard, or to synchronize their views and change it on his own device, thus requiring some kind of negotiating about using one set of keyboard, or to actively change your own current view.

### Referencing

As the nature of the task was to identify activities and choose a set of several possibilities with some minor restrictions or guidelines (they had to pick one each from three categories, and two from any category), an important set of interactions is when they referred to activities. Here it is valuable to think about how they *pushed* and *pulled* information as discussed by Flor [3]. The basic set of actions for pushing and pulling information concerning referencing are:

- X points at an activity on the large display (push), followed by Y looking at what X is pointing at (pull)
- X points at an activity on X's small display (push), followed by Y looking at X's display (pull)
- X points at an activity on Y's display (push) while Y is looking at his display (pull)
- X marks an activity by annotating on his display (push), Y looks at the large display to see where X makes the annotation (pull)
- X marks an activity by annotating while X's and Y's views are synchronized (push), Y sees the annotation on Y's display (pull)
- X mentions an activity verbally by name (push) assuming mutual knowledge of the activity

### Unacknowledged references

Even if these push/pull pairs naturally occurs, it is also common for pushing to occur without the corresponding pull. When X refers to an activity he does not necessarily wait for Y to acknowledge that Y understands which

activity X is referring to. The way X might refer to an activity can be quite ambiguous (e.g. "saying this", or pointing arbitrarily from a distance to the large display) as if the reference is more for the sake of doing a reference, rather than referring to a *specific* activity. Instead when Y is interested in the activity, Y pulls that information actively and he does this using different means. A common way is to glance at X's display to see his view. This is either followed by holding the focus on X screen and further talk about the activity or further plans, or it is followed by synchronizing the views by either panning or by holding the small device over the large display.

Another common way is to glance at the large display to see where X view is, and thereby get a clue of which activity it is. It is then a simple matter for Y to synchronize his own view of that is required. When done in this way there can become misunderstandings, where Y thinks he finds the activity but soon realizes he did not. When this happens there is some confusion which is resolved by Y looking at X display, X pointing at the activity on the big display, or X pointing at the activity on Y's display. However even when misunderstandings occur it seems to happen that other activities of interest are found, and thereby helping to solve the task, similar to when in [3] the solution for the task is found serendipitously (p. 215).

Thus, when X refers to an activity by pushing (either it be naming it verbally, pointing ambiguously toward the large display, pointing to his own display when Y is not looking, etc), Y must sometimes pull information several times, from several sources and often without requiring X to push any information. For instance, when X pushes the information verbally by saying "this", Y might pull information by first looking at the large display, synchronize his view, still not find it, and then pull again by glancing at X's display. Also in the case of misunderstandings, it can be resolved easily by different means by X pushing information again, referring to the same activity less ambiguously and letting Y pull this information again.

It is important to note here that since X refers to an activity without waiting for Y's acknowledgment, he is continuing to work on his own, until interrupted by Y or requiring Y's attention. The purpose of the referring seems to be to ensure a common ground to help the cooperation. It can be seen when comparing two groups where this occurs more frequent in one and less in the other, that there is a lack of cooperation. Here the group with the use of unacknowledged references work more together as a group and discuss their options before choosing, more than the group with less or nonexistent unacknowledged references.

### DISCUSSION AND CONCLUSIONS

The study shows that the system offers access to a shared workspace and the ability to switch between workspaces in multiple ways, thus providing awareness information and means to seamlessly shift gaze between workspaces, as

found important by Dourish and Bellotti [2] and Ishii et al [4] respectively. The shared workspace in the form of the large display is always present, and it also gives information about the partner's doings as it is seen on the large display. Also the partner's workspace is transparent through different channels, where X can either glance at Y's display, or look at Y's square on the overview display. It is also a simple matter for X to synchronize his view with Y by either holding his device over the area on the large display, or pan using the stylus.

The next step in our work is to continue analyzing the data. What is found in this paper is just a first analysis and the data promises to reveal more findings.

#### **ACKNOWLEDGMENTS**

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