A Usability Study of Awareness Widgets in a Shared Workspace Groupware System

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ABSTRACT
Workspace awareness is knowledge about others' interaction with a shared workspace. Groupware systems provide only limited information about other participants, often compromising workspace awareness. This paper describes a usability study of several widgets designed to help maintain awareness in a groupware workspace. These widgets include a miniature view, a radar view, a multi-user scrollbar, a glance function, and a "what you see is what I do" view. The study examined the widgets' information content, how easily people could interpret them, and whether they were useful or distracting. Observations, questionnaires, and interviews indicate that the miniature and radar displays are useful and valuable for tasks involving spatial manipulation of artifacts.

Keywords
Workspace awareness, shared workspaces, usability study.

INTRODUCTION

People maintain an ongoing awareness of others in physical workspaces like whiteboards and tabletops, and they do this using everyday perceptual abilities. For example, we can glance over at another person to see where they are working, or we might hear the sound of a particular tool that indicates what they are doing. In the virtual workspaces provided by real-time distributed groupware, these abilities are greatly reduced. Groupware systems reduce a person's visual field to the limited area of a computer screen, remove characteristic motions and sounds from actions, and complicate auditory and visual communication. The situation is made worse by groupware techniques like relaxed-WYSIWIS view linking, that can hide people's visible actions from one another.

As a result of these changes, people receive only a fraction of the information about others that they would in a face-to-face setting, and it becomes much more difficult to maintain awareness. One kind of awareness that is often compromised in the move to a groupware system is *workspace awareness*: the up-to-the minute knowledge a person holds about another's interaction with the workspace [10, 12]. This includes knowledge about who is in the workspace, where they are working, what they are doing, and what they intend to do next. Workspace awareness reduces the effort needed to coordinate tasks and resources, helps people move between individual and shared activities, provides a context in which to interpret utterances, and allows anticipation of others' actions.

Several CSCW projects have considered support for various kinds of awareness, including workspace awareness (e.g. [2,4,11]). One approach is to augment the groupware interface with new components—widgets—that show some of the missing information about other collaborators. For example, telepointers are commonly added to WYSIWIS ("what you see is what I see") workspaces to show people's location and focus of attention. In location-relaxed WYSIWIS systems [18], however, techniques like telepointers do not always work since participants may be working in different parts of the space. Awareness widgets that have been created specifically for relaxed-WYSIWIS workspaces include:

- radar views (e.g. [11, 1, 17]);
- group versions of traditional widgets, such as multi-user scrollbars [1, 16];
- graphical activity indicators (e.g. [20, 2])
- auditory cues (e.g. [2, 3, 7]).

However, only a few techniques have been tested, and then usually as part of an overall system evaluation. It is still unclear whether add-on widgets improve the effectiveness or usability of a relaxed-WYSIWIS groupware system.

We have carried out a study that examines the usability of awareness widgets added to a real-time distributed groupware system. Workspace awareness requirements are dependent on the type of activity, and in this study, we focus on construction tasks. In construction, the goal is to create a whole out of available parts, while satisfying constraints that govern how the pieces can be put together. Construction activities are thus based on artifacts (the pieces), and are inherently spatial: spatial relationships between artifacts are important, and the work is carried out by moving, arranging, and aligning artifacts in space. There are aspects of construction in many groupware activities. This study uses page layout, where participants construct a layout from columns, pictures, and headlines, as a representative of this class of tasks. In our investigation, we looked at three issues that underlie the usability of awareness widgets.

1. Does the augmented system present the right type and amount of information to the user?
2. Can this information be easily interpreted and applied?
3. Does the additional information intrude on individual work, by using up screen space or by distracting people from their tasks?

Our goals were to answer these three questions, and to determine whether users found the widgets to be effective and valuable. The following sections set the scene, describe our methodology and the widgets used, and report the results of the investigation. We then discuss issues underlying our results, their impact on designers of real-time groupware, and limits to the generality of our findings.

THE PROBLEM

Issues of workspace awareness have been around since Englebart [6] used telepointers and video images in his early groupware systems. Later work on WYSIWIS systems (e.g. [20]) found that people needed up-to-date information about others (such as who had just made a contribution) to collaborate effectively. In addition, studies of face-to-face collaboration showed the importance of being able to see actions such as gesturing, listing, and drawing [19]. Providing information is not the only concern, however: Ellis and colleagues [5] recognized the tradeoff between being well-informed about others' activities and being distracted from individual tasks. They state that "a good group interface should depict overall group activity and at the same time not be overly distracting" (p. 49).

With relaxed-WYSIWIS groupware, lack of awareness became a bigger problem, since increasing individual control reduces the group focus inherent in strict-WYSIWIS systems. Awareness in relaxed-WYSIWIS systems is still important, because even when people work in a loosely-coupled mode they remain connected to each other and "aware of others' presence, perhaps their activities and progress" [8] (p. 293). Gaver recognized the importance of awareness in helping people "shift from working alone to working together, even when joined on a shared task." As he says, "building systems that support these transitions is important, if difficult."

Dourish and Bellotti [4] apply these ideas more specifically to shared workspaces, and define awareness as "an understanding of the activities of others, which provides a context for your own activity" (p. 107). They also argue that awareness information should be passively collected and distributed rather than explicitly provided by participants, and it should be "presented in the same shared work space as the object of collaboration."

Drawing on these experiences, we have constructed a framework of workspace awareness that expands and adds precision to the concept [10,12]. The framework divides workspace awareness into several elements, each a kind of information that people maintain about others in a shared workspace. In this study, we concentrate primarily on support for awareness of location and activity.

METHODOLOGY

The study used observation, self-report, and interview techniques to gather information about the awareness widgets, and thus was a structured investigation but not a traditional controlled experiment. This section describes the participants, the organization and setup of the study, the groupware application, and our awareness widgets.

Participants

Nine pairs of computer science students participated in the study as paid volunteers. The first pair acted as pilot subjects to test the groupware system and the experimental methods. Four of the pairs had experience working with each other in class groups during the previous semester. All of the participants were familiar with the workstation, optical mouse, and window system. Most were familiar with the idea of groupware, but none had experience with real-time distributed groupware or the particular system used in the study.

Physical setup

Participants worked at Sun workstations with 19-inch colour monitors, separated by a divider so that they could see neither the other person nor the other workstation. However, participants could talk normally across the divider. Two experimenters observed and provided assistance when needed. A video camera recorded one workstation's screen and the participants' conversation.

Groupware system

A shared-workspace page layout application was built for the study, using the GroupKit toolkit [16]. The system's workspace simulated a two-page newspaper spread; the artifacts in the workspace included headlines, columns of text, pictures, and banners (see Figure 1A). Participants could move artifacts by dragging them, and could cut or join columns of text using the mouse.

Each person's main view occupied most of their screen, but showed only about one-third of the whole workspace. Participants could move their main view using scrollbars, and were able to position their views independently. In addition to the main view, various configurations of the system were augmented by awareness widgets. The widgets

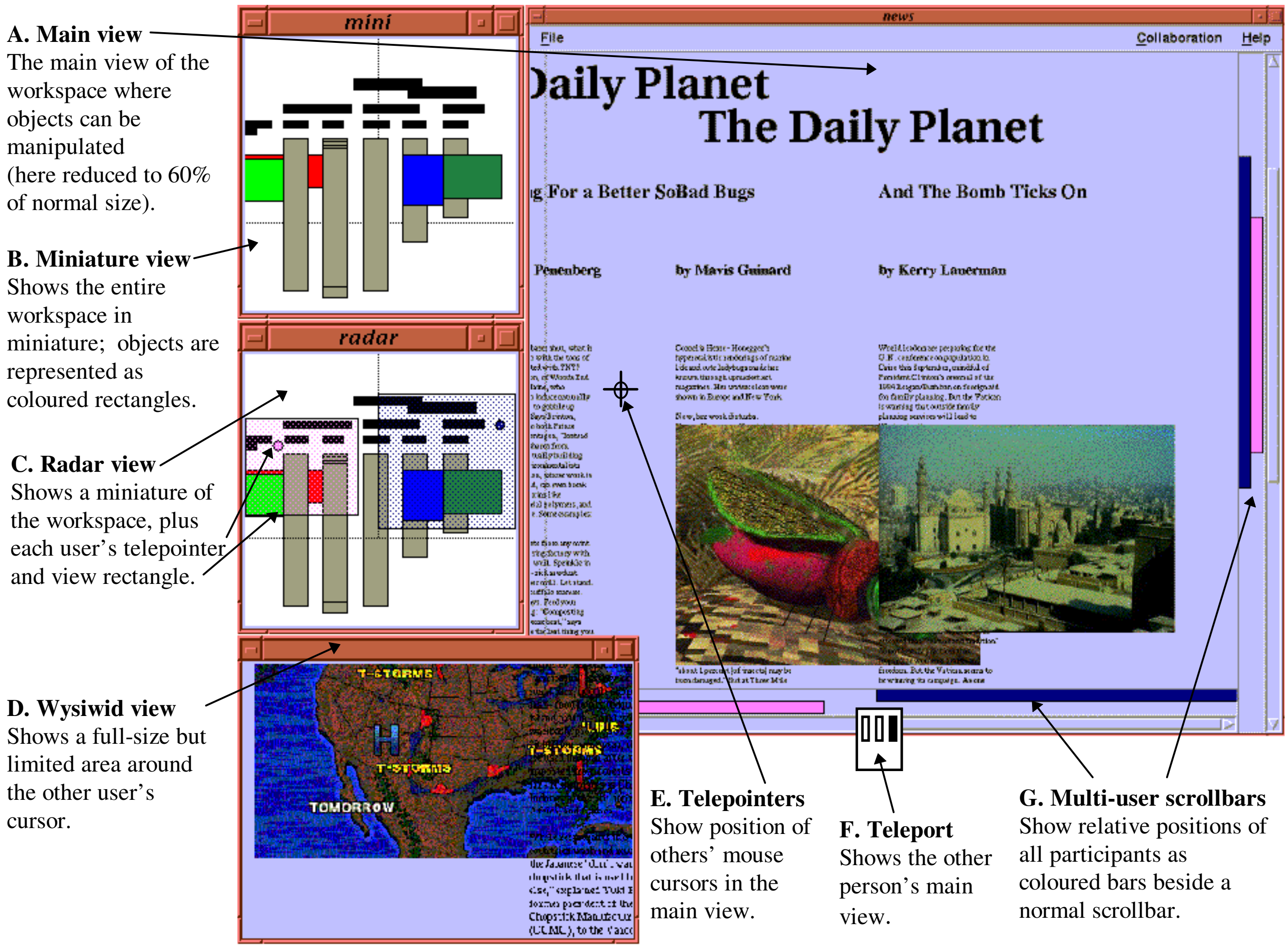

Figure 1. Awareness widgets and main view

are shown in Figure 1 and described below; some of them are also illustrated in a related video [13].

Widgets

In all configurations of the system, we included two techniques as basic support. First, the main view was equipped with *telepointers* (Figure 1E) so that people could see each others' mouse cursor when they were looking at the same objects. Second, we provided *teleporting* (Figure 1F) as a fast way of looking at the other person's part of the workspace; pressing the right mouse button would immediately scroll the view to the other person's location, and remain there as long as the button was held down. In addition to these basic features, systems could incorporate multi-user scrollbars, a wysiwid view, a miniature view, or a radar view.

The *multi-user scrollbar* (Figure 1G) shows each person's relative location in the workspace. The outside control is a standard scrollbar that allows people to move their own view. Beside the real scrollbar are indicator bars showing the current size and position of each person's viewport, each in a unique colour.

The "*what you see is what I do*" (wysiwid) view provides full-size details of another person's interaction, but shows only a limited part of their view (Figure 1D). The widget shows only the immediate context around another person's cursor, since most actions in graphical applications involve the mouse. As a person moves their cursor on a remote machine, the background of the widget pans to keep the display centred around the pointer.

The *miniature view* shows an overview of the entire workspace, reduced in area by a factor of 64 (Figure 1B). Each artifact in the workspace is represented in the miniature by a solid rectangle: text in grey, headlines in black, and pictures in different colours. Some information about others' activities is available through this display, since movement of or changes to any artifact are immediately duplicated in the miniature.

The *radar view* (Figure 1C) also uses a miniature view, but presents additional information about others' locations. The radar display shows the extent of what each person can see (their viewport) as a shaded rectangle, and also shows finer-grained location with telepointers that represent each person's mouse cursor. Participants are identified by showing view outlines and telepointer in unique colours.

Task

Newspaper page layout was used as an activity characteristic of construction tasks. Each group completed two tasks, and were instructed to lay out the pages using their own knowledge of what newspapers should look like. Groups started out with blank pages and stories grouped along the bottom edge of the workspace, and were allowed a maximum of fifteen minutes for each task. The pair was allowed to organize the completion of the task in any way they wanted, as long as they worked together; they were also asked to ensure that the two pages had a consistent look, a constraint designed to prevent pairs from working totally independently. Groups could ask the experimenters for assistance at any time.

Procedure

Participants were introduced to the study and asked to sign consent forms, and were then given a guided tour of the system, its functions, and any awareness widgets that were part of the configuration. Participants then practiced the system's functions, and when they felt comfortable, they began the first task. After fifteen minutes, the pair was stopped and given a questionnaire that explored their experiences with the system. This procedure was repeated for the second task. Finally, we conducted a short interview to investigate events that we had observed during the tasks and to explore particular responses on the questionnaires. Subjects were then paid and thanked for participating.

System configurations

Six system configurations were used in the study (Table 1). Since we were interested in observing a broad range of configurations and combinations, and in focusing on particular settings that we felt beforehand would provide useful information, we did not equalize numbers for each widget. The 'basic' condition shown in Table 1 refers to the system that included only the main view with telepointers and the teleport function.

System Configurations		
Pair	Task 1	Task 2
1	Basic	Radar
2	Radar	Basic
3	Mini	wysiwid
4	Scrollbar	Basic
5	Radar	Mini
6	Mini	Scrollbar
7	Radar	Radar & wysiwid
8	Radar	Basic

Total Pairs	
Widget	# Pairs
Basic	4
Scrollbar	2
wysiwid	2
Miniature	3
Radar	6

Table 1. System configurations and totals for each widget

Data collection

The experimenters recorded observations about the interaction and use of the system during the sessions. Questionnaires were given after each task; these used 5-point Likert scales and balanced positive and negative questions. Since this was an initial study and the participants were not experts, we did not measure speed, errors, or product quality. A short interview was also conducted and audiotaped at the end of the session.

RESULTS AND INTERPRETATION

The study considered whether the widgets showed the right information, whether they were easy to interpret, whether they intruded on individual work, and how participants felt about their value. The results that we gathered are organized below using these issues. We concentrate primarily on the four add-on widgets, but also consider the teleport function and main-view telepointers in some cases. We first present several general points that characterize our experiences in this study.

General observations

All of the groups completed their layouts, and appeared to enjoy using the system. We observed a variety of collaboration styles, from top-down divide-and-conquer approaches where the group assigned tasks and then went off and did them, to close cooperation where the two participants often worked on the same thing at the same time. In all of the pairs, manipulation of the artifacts was shared about equally between partners; we did not observe "single scribe" collaboration that has been noted in studies of collaborative writing [1]. Regardless of the style, all the groups used the relaxed-WYSIWIS capabilities of the system to focus at various times on separate areas of the workspace.

Even though the layout task did not force tightly-coupled interaction, it was clear that partners in all conditions maintained and used a sense of workspace awareness. We saw people gathering awareness information by asking their partner about where they were and what they were doing, or by watching them work. People also provided awareness information, primarily by verbally shadowing their own activities and intentions. We also observed utterances and actions that depended on awareness of location or activity, such as frequent deictic references to artifacts or areas of the workspace.

People also used the awareness widgets. Almost all of the participants were clearly interested in them, and gave us thoughtful comments and suggestions about how the widgets could be used or improved. In some cases, people even became quite passionate about the widgets, especially when the second system took away a widget that they had liked using in the first!

The subjects found the radar and miniature views to be the most useful. Participants gave more positive responses to the mini and the radar in both the questionnaires and in the interviews, and expressed their preference for them over the others when they had the opportunity to compare.

Participants reported that the miniature and radar were useful both because they assisted with a person's individual layout tasks, and because of the presentation of information about others in the workspace.

Amount and type of use

We regularly observed people making use of the widgets, and all of the participants said that they did use them, even if only to try them out. The amount of use varied across groups, and some widgets were used more than others. For example, eight of twelve radar users commented that they used the display often, but two of four users of the wysiwid display said they "never really used it."

The widgets were generally used in ways we expected. People reported that they primarily used the widgets to gather information about the other person in the workspace. However, the mini and radar displays were also used to aid individual work: for example, people often looked at the mini or the radar to manipulate text columns that were too long to be seen completely in the main view. The wysiwid view was used in more limited ways: one person said that when they knew "that my partner was on a picture…I would use the wysiwid to determine *which* picture."

In some cases, displays went unused because people forgot about them: several users said that they didn't remember to use the teleport function; another said "to be honest, I kind of forgot about the radar;" and a user of the mini said "most of the time, I did not notice it." Part of this problem may have been caused by placement and visibility. The teleport function had no visual reminder of its presence, and the other widgets were small and were placed in the corner of the screen. One user said "the location of the radar was not very good. [It] forced you to look quite a distance."

Information content

Our first goal was to explore whether the widgets collected and presented the right information. We discussed several issues of information content with the participants: amount and type of information presented, whether the displays adequately showed location and activity in the workspace, and whether there was any information missing from the widgets. We found that participants responded positively to widgets that provided more information; however, they also thought that additional types of information should be available.

Responses to questions about amount and type of information were consistently more positive for the systems that provided additional awareness information. That is, the basic configuration was ranked lowest, the scrollbars were given a neutral response, and then increasingly positive responses were given to the wysiwid, the mini, and the radar. This pattern was repeated for questions that asked specifically about whether the widgets adequately showed the location and activities of the other person. The participants' responses suggest that they saw a lack of information in the basic configuration, and that the widgets (especially the radar) provided some of what they needed for the task.

Participants also mentioned additional kinds of information that they thought should be presented. In some cases, their comments validated the information that was in other widgets such as the radar view. For example, the basic configuration was often found to be lacking in location information (e.g. it was "difficult to tell at times where my partner was working") and in information about the overall workspace (e.g. "[it was] hard to tell [the] layout of the page;" "[it] would be nicer with a full view of the 2-page area."). This information would have been provided by the radar view, and two participants using the basic system came up with the idea of miniature and radar views as ways to address these deficiencies.

Some of the requests concerned information about type of activity and intentions that was not available in any of the widgets. Four participants felt that information about "the type of operation being performed by my partner" was missing. Some subjects wanted to know when their partner was going to cut a column of text, and two others mentioned that they could not tell when their partner had grabbed an object to move it. This information would have warned them against trying to move the same object.

Participants also wanted information about their partner's intentions. A few comments concerned "what my partner was going to do next" and their "future plan." Participants agreed that this would be difficult for the system to determine, but some people did make concrete suggestions. For example, one subject wished that he had been able to mark the objects that he was planning to use in the near future, so that his partner would know not to take them.

Ease of interpreting the information

Once we had considered the information content of the widgets, we wanted to find out how easily the participants could interpret that information. We found that in several areas, the radar and mini displays were easier to interpret than the scrollbars or the wysiwid view.

Information about the other person's location was generally considered easier to interpret in the radar and mini views than in the other widgets. There are several reasons why the wysiwid view and the scrollbars caused problems. The wysiwid's animation was not smooth, which may have made it difficult to understand. One user said "identifying where your partner is hard because my partner's movement in [the wysiwid] is very jerky." Participants' responses to questions about the multi-user scrollbar indicated that although the scrollbars presented the relevant information, it was difficult to actually determine where the other person was. This may have more to do with integration of information than with any technical difficulties. The scrollbar showed each user's view location, but split the extents of the rectangular view into horizontal and vertical dimensions. To determine where someone was, a user had to mentally integrate information from the horizontal and vertical scrollbars. The radar widget, in contrast, showed view location in a form that was already integrated.

Subjects had little difficulty in determining who was who in the widgets. However, since there were only two people in the workspace, they often did not need the colour cues that the widgets use to distinguish participants. Several people looked for motion in the widgets to identify their partner, rather than remembering who was represented by each colour. For example, one subject determined his partner's location by "wait[ing] to see what was being done on the screen that was not connected to my actions."

Almost all of the participants reported that they were easily able to switch their focus between the main view and the widgets, despite the fact that two widgets showed the workspace at a different scale, and two showed different parts of the workspace. The overall ease may be due to representations that were similar to the main view, and therefore familiar to the participants. A few problems, however, were encountered with adjusting to the wysiwid view, and one subject suggested that it showed too little of the other user's view for him to figure out where it was.

Effects on individual work, collaboration, and product

We were also interested in how the widgets affected individual activities, and participants' feelings about the interaction and the final layout. We found that the participants were not distracted by the mini or radar widgets, and that several people felt the radar to have a significant positive effect on their work.

Subjects stated strongly that the mini and radar views did not distract them or slow down the completion of the task. One subject said "the mini display was not distracting in the least," and there is added evidence of the widgets' unobtrusiveness in the fact that several participants forgot about the displays altogether! Subjects were more ambivalent about the scrollbars and the wysiwid view. Two found that the scrollbars distracted them from their tasks, and another considered the wysiwid "almost distracting" because it "shows too small an area to gain any real benefit from it."

Five participants also expressed the belief that the radar and mini views did have a significant positive effect on the final outcome. For example, they said "we really needed the radar to help in the overall appearance," "the final result would have been much worse without the radar display," and "the radar screen made the task possible... I think without it would have been difficult to complete the task." There was, therefore, at least a perceived effect on the outcome.

Despite participants' enthusiasm for the radar and mini views, we did not see that particular configurations made obvious differences in the collaboration or final product. We informally reviewed the final products to see whether groups were able to complete the layout and whether there was basic consistency between the pages. All pairs were able to produce reasonable layouts in fifteen minutes, and participants responded positively to all systems when asked if they allowed efficient and effective collaboration. We also watched for signs of collaborative difficulty such as obvious communication breakdown or frustration, but groups with unaugmented systems did not seem to have more difficulty in coordinating or carrying out their tasks than groups with the mini or radar widgets. This may be due simply to people's ability to adapt their behaviour in information-poor situations: people are remarkably capable of finding information that they need through alternate means, and they can often find ways to complete their tasks without the missing information. Collaboration differences may appear, however, with more sensitive measures.

Perceived value

It was clear that the participants in the study found some of the widgets valuable. We asked participants whether the widgets they used were valuable additions to the groupware system, and whether the widgets were worth the screen space that they took away from the main view. Participants felt strongly that the radar was a valuable addition to the system, and that the radar and mini displays were worth their screen space. When comparing the two system configurations that they had used, participants almost always preferred configurations incorporating these widgets. We often received joking complaints when the second system "took away" the radar view. In addition, several people said that the radar view was important to the completion of the layout task, and there were numerous positive comments on the radar and mini displays. For example, different people said that they were "very helpful," "extremely helpful," "a must," and "a very useful tool in groupware applications." Although responses were mixed for the scrollbars and the wysiwid view, several people made suggestions about improving these widgets or speculated on situations where they would be more useful, indicating that they believed these devices had some value.

In the interviews, we also explored the reasons why the mini and radar displays were useful. Responses indicated that the value of the widgets was about evenly divided between their ability to assist individual work, and the workspace awareness information that they provided. That people found the awareness information valuable, above and beyond the overview, was also shown in the comments of three participants who suggested that the mini display could be improved by showing their partner's telepointer.

As a final point, a comment made by one subject has much to say about the promise of displays like the radar view for making virtual workspaces more natural. When asked about the widget's value, he said "it really felt like you were working on the same big table."

DISCUSSION

In addition to determinations about which widgets are appropriate for construction tasks, this study has given us additional insight into the issues underlying the usability of awareness widgets. In this section, we consider some of these issues, discuss the implications for groupware designers, compare our findings to previous work, and comment on possible limits to the generality of our conclusions. A recurring theme in the following paragraphs is the relationship between the information shown in the widgets and the spatial constraints of the task.

Underlying issues

The main results of the study are that the radar and mini views were fairly successful in helping people maintain workspace awareness in a page-layout task, and that the multi-user scrollbar and the wysiwid view were not. Some explanation of these findings can be found in broader issues such as the coupling between perception and action, and the relationship between awareness of oneself and of others.

Supporting group and individual awareness. It was clear from observations and participant comments that the radar and mini views were useful for individual work, such as moving long text columns, as well as for keeping track of the other person. This came as a surprise, as we had intended the global overviews simply as convenient backgrounds for workspace awareness information. In retrospect, however, it seems obvious that the overviews provide support for the layout task, since people relate to the task at both a global level (the general look of the layout) and a detailed level (the precise alignment of objects).

Our experiences suggest that the idea of workspace awareness should cover more than just knowledge of others' interactions with the workspace: it also includes knowledge of the state of the workspace and its artifacts, and of your own actions within that context. These three are closely tied together, of course: individual actions are undertaken in relation to what others are doing, and the state of the workspace is partly determined by the actions of others. Global overviews seem particularly useful in this light; since the workspace cannot be counted on to remain the way it was last time you looked, an overview helps to keep a mental picture of the space up to date.

Supporting perception and action. In some cases, even though the widgets presented the appropriate information and were easy to interpret, participants had difficulty making use of the information. One person said "it was easy to get info about my partner but the 'bridge' between getting info *about* and then proceeding to go over to *where* my partner was, is slow." In the situation he was describing, he had seen his partner do something in the wysiwid view that he wanted to help with, but it took him a long time to scroll his main view to where she was. These problems arose because the widgets were designed only to provide information, not to help people act on that information. One solution might be to provide better links between the widgets and the main view (a "Go There" button, for example), but a larger issue of perception-action coupling appears to underlie the situation.

Recent thinking in cognitive science suggests that perception and action are intertwined: exploration of an environment is directed by the information that we have already picked up [15], and our actions are informed by the on-going perception of feedback from the environment. Therefore, if the information provided by a widget is relevant and at the appropriate level of detail, then acting in that context and at that level of detail is also likely to be appropriate.

If the participant in the example above had simply been able to reach into the wysiwid view and move the objects shown there, the bridge between perception and action would have been considerably shorter. Other participants appeared to agree, in suggesting that they be able to manipulate objects in the miniature, or move their main view by dragging their radar view rectangle. It seems reasonable that awareness widgets be built simply as additional workspaces, each useful for a different level of awareness and a different level of activity. People can then gather information and act on that information in the most appropriate context, without having to shift to a different workspace.

Familiarity of representation. Experiences with the radar view illustrate the benefits of familiar representations for presenting awareness information. Subjects were able to use their existing knowledge of the workspace when interpreting awareness information in the radar view. The obvious similarity between the main workspace and the radar's scaled representation provides a familiar base on which to present other spatial information (such as view extents and cursor locations). The artifacts act as landmarks that tie the two representations together, and that help people find particular locations based on information in the radar. The differences in scale and in representation detail (i.e. objects were represented by boxes) did not appear to be a problem, suggesting that shape, relative size, and area provide sufficient cues for mapping between the radar and main views.

In contrast, the multi-user scrollbar did not present awareness information on a familiar base: it shows view location as a range (the indicator bar) on an abstract scale (the length of the scrollbar), which has no spatial connection to artifacts or distances in the actual workspace.

This presentation limits the information that can be drawn from the scrollbar to an understanding of whether two people share some part of their view, and unless the two indicators are perfectly aligned, it is difficult to determine exactly which artifacts can be seen by both people.

Lessons for groupware designers

This study has shown that support for workspace awareness can be a valuable and appreciated addition to a groupware system. Groupware designers should consider requirements for workspace awareness when they design shared-workspace systems, and can use add-on widgets to help people maintain awareness.

In particular, workspace overviews as used in both the radar and mini views can assist people in tasks where spatial manipulation and spatial relationships are important. If tasks require only general knowledge of others' locations and activities, the wysiwid display is likely to be ineffective, since it shows only the details of others' actions. Also, since integration of the spatial information is critical, it is likely that the multi-user scrollbar is not a good candidate for use in two-dimensional workspaces.

In addition to recommendations about particular widgets, our experiences suggest that future studies of groupware should include criteria for assessing awareness. Standard usability evaluation methods generally do not assess support for the group dynamics of a shared workspace system. Criteria such as information content and ease of interpretation should be used more generally to consider how groupware provides information about other participants.

Comparison to previous work

A number of this study's conclusions can be contrasted with previous CSCW research. In particular, we consider previous usability studies of awareness widgets, the issue of distraction, and the principles of passive collection and workspace presentation of awareness information.

Baecker and colleagues [1] report on the only other usability study that we know of to include awareness widgets. They evaluated a synchronous text editor that included a multi-user scrollbar and a text overview similar to the radar view. They do not provide detailed results, but say that "most subjects were able to use SASSE's... collaborator awareness mechanisms successfully" (p. 404). This stands in contrast to our participants' difficulties with the multi-user scrollbar. However, this widget is likely more suited to a text editor than it was to our system, since text usually has only one dimension, and since relative positions may more closely represent the way people think about location in text documents.

Ellis, Gibbs and Reinconsidered the issue of distraction in groupware interfaces [5], and state that these interfaces should present information but not be overly distracting. Our study, in which the radar view was not considered distracting, leads us to some speculation on this issue. It is commonly thought that distraction is caused by perceptual information that draws our attention, but distraction may have as much to do with interpretation difficulty. If people already have a good sense of workspace awareness, then changes in a display like the radar are expected and will generally not distract. Ellis et al. state that groupware participants "are generally not as aware of others' contexts and can less easily interpret sudden display changes resulting from others' actions" (p. 49). To this we add that if people can stay aware of others' contexts, then display changes will be easier to interpret and thus less distracting.

Dourish and Bellotti [4] give two principles for supporting awareness in groupware workspaces. One is that awareness information should be "presented in the same shared work space as the object of collaboration" (p. 107). The widgets in this study show, however, that awareness information can be successfully presented outside the main view. Other systems do so as well: for example, Cognoter [20] indicated activity in the icon of a closed window, and several systems have presented sound cues separate from any workspace (e.g. [3,7]). In our view, a more general principle should be used: that awareness information must be easily interpretable regardless of where it is presented. We agree, however, that one way of simplifying interpretation is to build on people's existing knowledge of the workspace.

The other principle stated by Dourish and Bellotti is that awareness information should be passively collected and distributed by the system, rather than explicitly generated by the participants. Again, we agree with the principle in general; however, two episodes in our study suggest that there are situations where it does not always hold. First, we regularly observed people verbally shadowing their own behaviour (e.g. "now I'm moving the picture up to the top..."), an activity that we and others have seen in other group situations (e.g. [14]). People take on the task of shadowing quite naturally, without any prompting. It may be an indication that people are interested in helping their collaborators maintain awareness. In the second episode, a subject suggested that he should be able to mark objects in the workspace in order to indicate to his partner that he intended to use them in the near future. This is an example of information that cannot be passively gathered by the groupware system, and suggests that some awareness information can only be generated explicitly by the participants.

Critical reflection

There are a variety of issues that may limit the generality of our conclusions. The two most important concern group size and task type.

The first issue considers how the widgets will scale to larger groups. Many of our results may change somewhat if more than two people are in the workspace. It is possible that larger groups would begin to fill the radar widget: the subject who thought that two view rectangles cluttered the display might be joined by several others when there are four rectangles. In the mini view, participants will have far more difficulty in determining who is moving an artifact, since they can no longer adopt the "if it's not me, then it's my partner" identification strategy. Although the radar shows different coloured telepointers that can assist in identifying people, this technique forces users to map colours to people. The wysiwid display and the glance capability are not themselves affected by additional people, since they show only one person; however, users would have to decide whom they wished to track using these display, or sacrifice more screen space to have multiple wysiwid views. We believe that none of these concerns would render the widgets useless in a larger group, but it is obvious that they must be examined in more detail.

The second issue concerns how our results generalize to tasks other than page layout. Layout is one kind of construction task, and shares several characteristics with others of this variety. For example, the task is completed through spatial manipulation of the artifacts, and both the spatial relationships between artifacts and the overall appearance of the workspace are important factors in completing the task successfully. Overview widgets such as the radar view should thus be useful in other kinds of construction tasks, such as drafting, assembly, or design, as they help a person maintain a model of spatial changes in the workspace and a sense of awareness about how the changes are being made.

In task types other than construction, we are less sure about the utility of these widgets. However, we note that many other types of tasks either have spatial components or use the inherent spatiality of a two-dimensional workspace as an organizing principle for the artifacts. In other types of tasks, however, overviews may need to be organized differently. For example, a text document may be better served by an outline overview rather than a miniature representation of every line [13].

Future work

We plan to build on this work in several ways. First, we will incorporate some of the participants' suggestions into new versions of the widgets. In particular, we will improve the bridge between perception and action discussed earlier, and add support for declaring intentions. Second, we will address the concerns raised in the previous section, and test the widgets with larger groups and on other kinds of tasks. Third, we hope to undertake further studies that use stronger measures of the widgets' effectiveness, such as quality of product or time to completion. Finally, we also plan to test new designs, such as a fisheye workspace that uses multiple focal points to convey both global and detailed information [9].

CONCLUSIONS

This paper has described a usability study of awareness widgets added on to a shared-workspace groupware application. Two displays based on miniature overviews of the workspace were particularly useful in layout tasks, both for individual activities and for maintaining workspace awareness. We expect that the issues raised here will motivate groupware designers to continue exploring awareness, with the goal of building shared workspaces that are as natural to use as their physical counterparts.

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Software Availability

The page layout system used in this study and the GroupKit toolkit are freely available. For more information, visit:
http://www.cpsc.ucalgary.ca/projects/grouplab/

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