The Use of a Shared Drawing Surface as a Co-ordination Tool

M. MAZIJOGLOU¹, S.M. CLARK² and S.A.R. SCRIVENER¹

¹*Design Research Centre, Faculty of Art and Design,
University of Derby, Derby, UK*

²*LUTCHI Research Centre, Department of Computer Studies,
Loughborough University of Technology, Loughborough, UK*

CONTENTS

	Page
ABSTRACT	164
KEY WORDS	164
INTRODUCTION	164
Shared View Systems	165
A Prototype Shared View System	166
THE EXPERIMENTS	167
Experimental Aims	167
Experimental Conditions	167
Experimental Task	168
Experimental Procedure	169
RESULTS AND INTERPRETATION	170
Time Taken to Complete the Task	170
Data Analysis	170
<i>Understanding</i>	171
<i>Collaborative contribution</i>	171
DISCUSSION	174
CONCLUSION	175
REFERENCES	176

ABSTRACT

Shared view systems allow groups to share single-user computer applications whilst working in distributed collaborative settings. While these systems are useful for sharing applications in situations where all members of a group have similar skills, they are not so suited to situations where group members have differing skills. In some contexts certain group members may not have the knowledge or desire to operate the single-user application, yet they may still wish to comment on the shared view and indicate possible alterations to it. How does one offer support to these users? This paper describes a series of experiments in which a shared drawing surface was integrated with a shared view system in order to explore this issue empirically. It is concluded that there are significant benefits in adding pointing and drawing facilities to a shared view system. Additionally, the study illustrates how group dynamics are influenced by the resources available to each participant.

Key Words

Shared View Systems, Co-ordination Tools, Telepointing, Drawing, CSCW

INTRODUCTION

Computer Supported Cooperative Work (CSCW) and Groupware systems provide geographically separated groups with technology to support collaborative activity. Such systems are often homogeneous, in the sense that each user of the system is provided with the same technology, same system functionality and same view of the artifacts being shared. However, work groups are not usually homogeneous; members may differ in terms of knowledge, skills, status, influence and so on. A work group may also encompass a heterogeneous world of technology and resources. For example, the computer applications available to each member of a group may differ in relation to their individual skills, work patterns and

preferences. Hence the question is raised, "How do we create CSCW systems that allow individuals to use their existing tools and skills when working in a distributed group context?"

In this paper we explore an approach to supporting synchronous collaborative activity between distributed work groups in which a single-user application is integrated with a group 'co-ordination tool'. In essence, we set out to test the hypothesis that a simple computer-mediated communication environment which supports verbal communication, 'telepointing' and shared drawing can provide an effective means of co-ordinating group interactions with task objects manipulated by a specialist using a single-user computer application.

Shared View Systems

Shared view or shared window systems allow groups to share single-user applications in collaborative settings. Typically, such systems allow users at different computer workstations to view and control each other's computer screens or to 'share' particular application windows (for examples see, Farallon, 1988; Garfinkel et al., 1989; Lauwers and Lantz, 1990; Greenberg, 1990). The shared view (be it an entire screen or an application window) is normally identical for each participant. Hence, users are able to use deictic references (e.g. statements such as "the top left") when discussing the shared view over an audio link. At any one time, only one member of the group has full control over the shared view (i.e. the single-user application). Control can be passed between group members either via verbal agreement or via the use of a 'floor control' mechanism.

While these systems are useful for sharing single-user applications in situations where all members of a distributed group have similar skills, they are not so suited to situations where group members have differing skills. As discussed in the introduction to this paper, in some contexts certain group members may not have the knowledge or desire to operate the

shared application. Yet these group members may still wish to comment on the view and indicate alterations to it.

It has been suggested that giving users the ability to point and draw over a shared view may be a way to approach this problem (Lauwers and Lantz, 1990). However, the implications of adding such facilities to a shared view system are largely unknown. The following sections of this paper describe a series of experiments in which we integrated shared drawing surface with a shared view system in order to explore this issue empirically.

A Prototype Shared View System

For our experiments we constructed a prototype shared view system by using a combination of computer and video technologies. The technology we employed was similar to that used in the LookingGlass system (Scrivener, Clark and Keen, 1992).

The shared view system can be used by two persons. Each collaborator is provided with a computer monitor upon which an image of a single-user workspace is "overlaid" with a shared drawing surface window. The single-user workspace can either be "physical" (i.e. a video camera image of a desktop) or "computer-based" (e.g. an image of a third computer screen). The shared drawing surface, called the ROCOCO Sketchpad (see Clark and Scrivener, 1992; Scrivener et al., 1992) provides comprehensive sketching and pointing facilities. When using the system the effect is one of seeing the image of the single-user workspace "under" the shared drawing surface. Both shared view screens show exactly the same image. This arrangement means that one user has direct control of the single-user workspace and the other user has the ability to point and draw over a view of that workspace. The first user is able to see any gestures and marks made by the second.

THE EXPERIMENTS

Experimental Aims

Our investigations into the use of the shared view system involved running fifteen experimental sessions — five each under three different experimental conditions. In each session a pair of subjects was geographically separated and asked to work together on a given task using the shared view system. The primary aim of the experiments was to determine the extent to which the drawing surface supports a pair by facilitating their communication and collaboration. Additionally, we were interested in determining the extent to which certain communication facilities supported a subject in his or her 'role' as a member of a team.

Experimental Conditions

The three experimental conditions were generated by constructing three variations of the shared view system. All three variations provided users with a shared view screen but in two conditions certain shared drawing surface facilities were removed. Each condition also provided a high-quality audio link. The communication channels made available to the subjects in each condition were:

- Talk Only setting — a channel for verbal communication and a shared view of a single-user workspace;
- Talk and Point setting — a channel for verbal communication, a shared view of a single-user workspace and a facility for pointing over the shared view;
- Talk, Point and Draw setting — a channel for verbal communication, a shared view of a single-user workspace and facilities for pointing and sketching over the shared view.

The single-user workspace was generated by taking a video signal from the monitor of a third Macintosh computer which was running a software application package. In each of the fifteen experimental sessions one subject per pair had control of this computer via a mouse whilst being able to see a shared view screen (displaying an image of the third Macintosh screen overlaid with the shared drawing surface). The other subject had a shared view screen and, depending on the condition, use of the shared drawing surface which could be controlled using a digitising tablet and stylus.

Experimental Task

The task was an electronic form of the Tangram puzzle. This puzzle involves positioning a set of polygon pieces to form a given goal shape. For example, Figure 1 shows how Tangram pieces can be arranged to form a "boat" shape. For our experiments the Tangram pieces were drawn using SuperPaint on a Macintosh computer. It was possible to manipulate the electronic Tangram pieces from within the SuperPaint package to form different goal shapes. A Macintosh displaying the SuperPaint Tangram pieces formed the single-user workspace to be used in the experimental sessions.

In each experimental session the collaborators had to use all the SuperPaint Tangram pieces available to produce a pre-defined shape. The pieces were all correctly oriented when drawn in SuperPaint, hence there

Fig. 1: Arranging Tangram pieces: (a) the pieces; (b) the goal shape; (c) the pieces arranged to form the goal shape.

was no need for the collaborators to rotate them. The goal shape was only given to the collaborator in each session who did not have direct control of the single-user workspace — this collaborator is referred to below as the "Viewer". No information on how to form the shape with the pieces was given. The other collaborator — the "Controller" — had to manipulate the Tangram pieces to form the goal shape. Both collaborators had to jointly work out the correct way to align the pieces.

The Tangram task was chosen because it represented the kind of "real world" collaborative activity that was of interest. That is, a setting in which the collaborators (in this case named the Viewer and the Controller) are able to contribute different knowledge and abilities to the task at hand.

All the fifteen pairs of subjects were given the same task. Clearly, the three conditions each provided different means for the Viewer to communicate the goal shape to the Controller and for the Viewer to make suggestions as to the solution of the problem.

Experimental Procedure

The subjects were told that the session would involve working with their partner to arrive to the required solution to the given task and that the experiment would last at most for 45 minutes. It was made clear that only the Controllers had direct access to the Tangram pieces. The Viewers were given the goal shape for the task and were expected to describe it, using any of the facilities available, to their partner and work with them to discover the desired solution. The Controllers were able to move the pieces around by using a mouse to select and move each piece individually. The subjects were also told that they should use all the Tangram pieces available; that the pieces shouldn't overlap; and that the pieces were already in the correct orientation. The time taken for each pair to complete the puzzle was measured. After each session both members of the pair were given a questionnaire. The questionnaire asked them to rate each of the following statements on a scale of 1 (strongly agree) to 5 (strongly

disagree):

- I didn't have any problems understanding what my partner was saying/doing;
- At times I felt my partner couldn't understand what I was trying to say/do;
- I felt I couldn't contribute to the solution;
- I felt my partner was guiding my actions;
- I felt my partner was in control of the sequence of actions taken.

RESULTS AND INTERPRETATION

Time Taken to Complete the Task

Figure 2 shows the total time taken to complete the task in all three conditions. It can be seen that, on average, the collaborators solved the Tangram puzzle faster when the Viewer was given a pointing facility and faster still when additionally given the ability to draw over the shared view. Clearly, the largest decrease in the time taken occurs with the addition of the pointing facility.

Having shown that the addition of pointing and drawing facilities to a shared view system offers measurable benefits in terms of task performance (at least for the type of task used in the experiments) the following sections examine the users' subjective view of their performance under each experimental condition.

Data Analysis

For analysis purposes the questionnaire results are presented under

Fig. 2: Total time taken to complete the task per condition.

two headings: "Understanding" (questions 1 and 2) and "Collaborative Contribution" (questions 3, 4, and 5). The average response to each question, for each condition, has been produced.

Understanding

From Figure 3 it can be seen that generally both collaborators felt they understood their partner and that their partner understood them. As the communication channels available to the Viewer increases this sense of understanding also increases and differences in understanding between the Viewer and Controller decrease. Whereas the Controller's understanding of the Viewer, and sense of being understood, increases, the Viewer gains primarily in terms of communication effectiveness. It is perhaps not surprising that the Viewer's understanding of the Controller (Figure 3a) does not vary as the Controller's resources were constant throughout the three conditions.

Collaborative contribution

Considering Figure 4, it is clear that with additional communication channels the Viewer's contribution to the problem and ability to guide and

Fig. 3a: Average responses to the question "I didn't have any problems understanding what my partner was saying/doing" per condition.

Fig. 3b: Average responses to the question "At times, I felt my partner couldn't understand what I was trying to say/do" per condition.

control the activity increases. In contrast, the Controller gains in these areas when the Viewer is provided with pointing, but then loses out when the Viewer is provided with a facility for drawing.

The differences between subjects in terms of their perception of contribution, guidance and control is greatest in the Talk, Point and Draw

Fig. 4a: Average responses to the question "I felt I couldn't contribute to the solution" per condition.

Fig. 4b: Average responses to the question "I felt my partner was guiding my actions" per condition.

Fig. 4c: Average responses to the question "I felt my partner was in control of the sequence of actions taken" per condition.

setting. This difference favours the Viewer. In the Talk Only setting it would appear that both partners feel that they are being guided and controlled. This probably reflects the difficulty of communication in this situation. For example, in this condition the Viewer has to rely on the Controller to follow requests to pick up and move pieces etc., and in this sense feels guided and controlled (Figures 4b and 4c). Conversely, the Controller must follow the Viewer's instructions and so feels controlled and guided: in other words, neither feels able to carry out actions independently of the other.

In any case, from Figure 4 it is clear that when the Viewer is provided with a facility for pointing, both partners' sense of contribution to the task and freedom to act independently increases. However, when drawing is added to the Viewer's available repertoire of communication media the Viewer generally achieves further gains in this area, whereas the Controller experiences a general sense of loss.

DISCUSSION

These results lead us to conclude that both subjects obtain benefits as the Viewer's communication resources are increased. Clearly, the major benefits arise through the introduction of pointing, although the ability to draw also produces benefits, particularly for the Viewer. Furthermore, the asymmetries in communication media and collaborative contribution indicate significant changes in the role of media and nature of collaboration.

The actual pattern of collaboration appears to vary quite radically with the introduction of different media. In the Talk Only setting, both partners feel controlled and guided by each other. However, the Controller feels more able to contribute to the solution than the Viewer. This is probably because the Viewer is occupied for much of the time just trying to explain the overall solution to the Controller who, although required to point on behalf of the Viewer (i.e. use the single-user application's cursor to confirm

the Viewer's statements), is able to find time to search for a solution to the problem.

The Talk and Point setting is the most balanced with both the Controller and Viewer feeling able to make a significant contribution to the solution, and balanced with respect to controlling/guiding and being controlled/guided. Clearly, giving the Viewer the ability to point gives both partners greater independence.

In the Talk, Point and Draw setting, the introduction of drawing provides yet another shift in subjective viewpoint. Here the Controller is unable to contribute as much, and feels guided and controlled by the Viewer, whereas the Viewer contributes positively to the problem and feels in control of the actions taking place. It is probably the case that the Viewer uses drawing to quickly get the shape of the solution across to Controller, and in so doing is able to develop solution ideas that the Controller is then instructed and guided to fulfil.

It is clear that the subjects' view of their contribution to the collaboration process alters as each medium is added. Significantly, as media are added the Viewer gains more influence and control over the interaction and the task, even to the extent that Controller is disadvantaged by comparison.

CONCLUSION

We have argued that persons who wish to, or must, work together may differ in a number of important ways. For example, they may not have the same level of computing experience and even though they might use the same kind of application (e.g. a desktop publishing application) they may have a preference for, or only have experience of, one particular application; alternatively they may have quite different skills and expertise. Hence, even if every existing single-user application could be made into a "Groupware" application it may be unlikely that collaborators would be

prepared to learn how to operate the same Groupware application.

In this paper we have proposed an approach that allows existing single-user applications to be integrated with a "co-ordination" tool. We have demonstrated that a communication "layer" over a single-user application provides a powerful tool by which a user who lacks control of an application can communicate intentions, and guide the application controller. Real benefits in time and influence are achieved by adding a pointer to a shared-view and speech configuration that allows a "viewer" to refer to and gesture about application objects.

A further small saving in time is achieved by the inclusion of a drawing facility, but the real significance of drawing, at least in the case of the task studied, is the increased control over the task it gives the viewer, compared to that possible simply via speech and pointing. Finally, it can be seen that, in the task studied, visualisation through drawing produced a change in group dynamic.

REFERENCES

- Clark, S. and Scrivener, S.A.R. (1992), *The ROCOCO Sketchpad Distributed Shared Drawing Surface*, LUTCHI Report 92/C/LUTCHI/0150, LUTCHI Research Centre, University of Technology, Loughborough, UK.
- Farallon (1988), *The Timbuktu User's Guide*, Farallon Computing Inc., Emeryville, California.
- Garfinkel, D., Gust, P., Lemon, M. and Lawder, S. (1989), *The SharedX Multi-user Interface User's Guide*, Technical Report STL-TM-89-07, Hewlett-Packard Laboratories, Palo Alto, California.
- Lauwers, J.C. and Lantz, K.A. (1990), Collaboration Awareness in Support of Collaboration Transparency: Requirements for the Next Generation of Shared Window Systems, *Proceedings of CHI'90*:

ACM Conference on Human Factors in Computing, pp. 303-311,
April 1990.

Greenberg, S. (1990), Sharing Views and Interactions with Single-user Applications, *Proceedings of OIS'90: ACM Conference on Office Information Systems*, pp. 227-237, April 1990.

Scrivener, S.A.R., Clark, S.M. and Keen, N., The LookingGlass Distributed Shared Workspace. To appear in *Computer Supported Cooperative Work: An International Journal*, Kluwer Academic Publishers.

Scrivener, S.A.R., Clark, S.M. et al. (1992), Designing at a Distance: Experiments in Remote-Synchronous Design, *Proceedings of OZCHI'92: CHISIG Annual Conference*, pp. 44-53, Queensland, Australia, November 1992.