Collaboration on a Large-scale, Multi-touch Display: Asynchronous Interaction and Multiple-input Use

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Abstract
This research explores two aspects of collaborative use on a large-scale multi-touch display: asynchronous access and multiple-input use in group work. We conducted a user test in an experimental setting to study group interactions on a shared display. We discuss how asynchronous touch interactions could support collaborative performance on the display, as well as how the type and number of input impact collaboration.

Author Keywords
Large shared display; asynchronous interaction; multiple inputs; collaboration

ACM Classification Keywords
H.5.2 [User Interfaces]: Input devices and strategies; H.5.3 [Group and Organization Interfaces]: Asynchronous interaction; H.5.3 [Group and Organization Interfaces]: computer-supported cooperative work

Introduction
Touch applications were developed on the assumption of single users, so traditional software does not offer a synchronous mode in input and control situations,. Most

touch applications, except game applications developed for multiple players, are optimized for the interaction of single users with applications that support individual tasks on small screens [2]. In addition, while the large shared display is conducive to multi-user collaboration, there are issues in improving unbalanced participation through monopolized access in the collaborative environment [1]. In this research, when performing group activities on a large multi-touch display, we focus on user interactions that occur in asynchronous access on touch applications. Since the display allows users to use a keyboard and a mouse along with direct touch interaction, we investigated how these input options might provide users more opportunities for collaborative interaction. Primary research questions from the study are as follows:
(1) How does asynchronous access on the large multi-touch display support collaborative performance?
(2) How can multiple input options facilitate collaboration?

User Test

We conducted a group user test in the lab where the large-scale multi-touch display, approximately ten feet by four feet high, was equipped and ready (see Figure 1).

The user test included four kinds of questionnaires: a pre-test questionnaire, two task questionnaires, and a post-test questionnaire. A five-point Likert scale was used for measuring the variables in each questionnaire. We took observational notes while participants performed the tasks in groups. Finally, group members were interviewed together as well.

Participants

We focused on collaborative activities in a learning environment and targeted students and staff at the university level. A total of 24 participants (17 females and 7 males), aged 18 to 41 years old, were recruited from The University of Texas at Austin. They were divided into eight groups of three participants each.

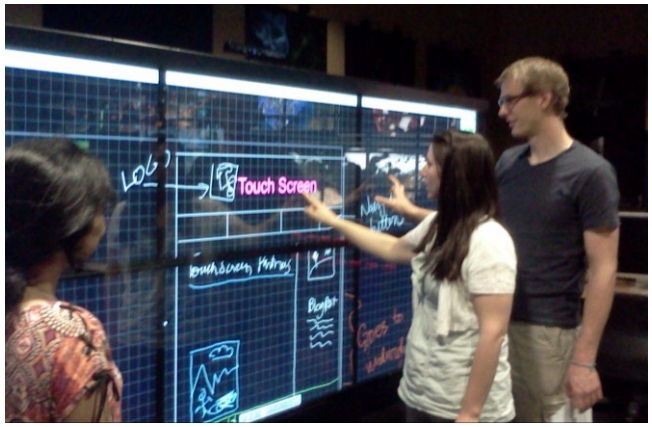

Figure 1. The large-scale multi-touch display used in the test

Tasks and Input Settings

Two task-oriented touch applications, Sankoré and pyFlowChart, were selected for testing collaborative task performance in asynchronous interactions. A set of two tasks was designed for each of the two applications. Task 1 was to sketch layouts for a newspaper's web pages by using Sankoré. Task 2 was to make a flow chart describing the process of posting a news story from www.nytimes.com onto social media. For this task, pyFlowChart was used.

Two different input conditions were set during the user test in order to gauge user behavior and touch interaction according to how input options were used.

In condition A, participants used only direct touch interaction for completing a task. Condition B allowed participants to use both hand-based touch manipulation and shared input devices, including a keyboard and a mouse. The presentation order of input conditions and tasks were systematically controlled through a randomized block design with two replications in the test.

Procedure

Before beginning the first task session, the participants were briefed on this research and filled out a short pre-test questionnaire. All groups had 15 minutes to complete each task. There was no training or warm-up period before the tasks. After each task test session, the participants were asked to answer a task questionnaire. After completing the second task, they completed a post-test questionnaire. Finally, each test group proceeded to take an interview together.

Results

From the user tests, the data from the questionnaires, completed tasks, observations, and the interviews were collected and analyzed.

Asynchronous Interaction and Collaboration

Both task questionnaires show that the users performed collaborative work with less conflicts in interaction. The means for the comfort level, liking group members, communication, coordination, and overall awareness of members were above average (3 out of 5). The difference in all the variables of collaboration between the two tasks was not significant. As we expected, this suggests that the high level of collaboration can be attributed to other aspects, such as touch interaction and the large display environment. The size of the display provided a workspace that allowed free movement among members, yet was so large that one could lose sight of an object on the other side of the screen. This resulted in strong cooperation through communication about what they saw and were doing between members. For instance, a group member discovered functions far away from the central workspace, and then dragged and passed a box to another group member.

Users quickly recognized that the applications did not support simultaneous access from multiple users. This caused confusion and frustration. However, the asynchronous access encouraged users to collaboratively complete tasks. Non-touch group members looked around the interface of the application and informed some members about different functions available, while one person took over touch manipulation. Some participants felt that they cooperated more in task 1 because they had to tell other group members to stop a certain task and take turns. Since everyone paid a lot of attention to each other’s touch activities, often when group members had difficulty with a touch interaction or made mistakes, everyone ended up helping other group members use the application. In addition, more cooperative situations caused a great deal of verbal communication between group members.

During the interview, several participants expressed concern over being too dominant in using the touch display, even though some participants gave others a chance at drawing something. We observed that acquainted users are more likely to engage in touch interaction and enter each other’s space. There may be reluctance or discomfort to share screen space with

new people in group work. On the application side, providing a split-screen option could accommodate use among multiple strangers.

Touch Input vs. Multiple Inputs

With regard to input conditions, the results show that the users preferred the use of both touch interaction and traditional input devices. Task evaluation shows that participants completed tasks well under the condition to use multiple input options, including a shared keyboard and mouse, as well as during tasks that used only direct touch. Users tended to depend on other input devices when they encountered difficulty using touch operations. This suggests that traditional input devices provide users with familiar and reassuring aids alongside touch interaction. It appears that in addition to touch input, the offering of physical devices for manipulation on touch interfaces can improve both performance and user experience.

One interesting result was that three variables (ease of use, time spent on task, and satisfaction) in task 2 are ranked higher under multiple input use than under only touch input. This suggests that the participants preferred the use of a traditional keyboard and mouse along with hand-based touch interaction for efficiency on a multi-touch oriented and enabled application over the single touch application of task 1. In addition, they sequentially tried a single tap and double taps many times when they had difficulty manipulating objects on the surface. Since most users (87%) have experience with personal touch devices and applications, this indicates that they might have an intuitive and similar expectation for controlling functions with single and double taps.

When using multiple forms of input, individuals took on specific roles, such as "touch person" or "keyboard person." The divided roles on input options result in varying efficiency on collaboration. Some groups were able to use this to efficiently organize group work, with each member acting out a role to help the team accomplish a common goal. Conversely, when group members did not effectively use the multiple input options, the condition generated frustration and confusion.

Discussion

Our results show that collaboration on the shared display has influenced task efficiency, depending on how they effectively cooperate with others in the display context and with multiple input. Both asynchronous access and multiple input led users to take on both separate and cooperative roles in task performance. Consequently, the peer interaction has increased attention on work practices and verbal communication in groups. Additional input aids like keyboards and stylus pens could also help support group collaboration.

References

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