Using Multiple Display Environments for Affinity Diagramming

Tejinder K. Judge, Pardha S. Pyla, D. Scott McCrickard, and Steve Harrison
Center for Human-Computer Interaction
Virginia Tech
Blacksburg, VA 24060
{tkjudge, ppyla, mccricks, srh}@vt.edu

ABSTRACT
Affinity diagramming is a commonly used contextual design practice in the development of interactive systems. Currently many tools exist that attempt to support the process of designing. However, experts and novices alike eschew tool use, instead preferring traditional paper and whiteboard methods. In this paper, we explore the potential of using Multiple Display Environments (MDEs) for the process of creating, sharing, and reusing affinity diagrams. We believe that by considering the fundamental activities involved in affinity diagramming and designing to support these activities, MDEs could be an effective technology for this domain.

Author Keywords
Affinity diagram, collaboration, multiple display environments, CSCW.

ACM Classification Keywords
H.5.3 Group and Organization Interfaces: *Collaborative computing.*

INTRODUCTION
Most software engineering and usability engineering endeavors are inherently collaborative, requiring group work to analyze, create, and share work products. Many collaboration tools such as GUNGEN [16], CDTools [1], Designer's Outpost [13], Team Storm [8] and IMPROMPTU [4], have been designed to support such collaborative work. In general, the success of these tools depends on their effectiveness in supporting the collaboration process without imposing extraneous equipment and interaction overheads.

In most software engineering and usability engineering life cycles, designers interview and observe users in their natural work environment with a goal of extracting user needs for the intended software system. One popular technique, commonly used in contextual design [3, 9] as well as other business practices, that aids in this process is *affinity diagramming*. In this technique, groups of participants engage in a collaborative decision-making process to identify and consolidate data gathered from user interviews or brainstorming sessions into a hierarchy of related categories. The process of constructing an affinity diagram is typically performed using sticky notes and any large wall surface. The first step in this process includes writing or printing qualitative data snippets from user interviews and brainstorming sessions, on sticky notes. Each note has one idea or theme, and the team collaboratively places notes with similar ideas into clusters on the wall. Once all the notes are placed into clusters, the team creates category labels for each cluster and defines the relationship among groups [9].

Using this technique it is possible to effectively analyze large amounts of data in order to highlight common themes across data gathered from user populations prior to designing a new product [3]. Often, affinity diagrams span large workspaces and are often dismantled after creation due to a lack of dedicated wall space in most software development environments [3, 9]. Moreover, *little is said about the life of an affinity diagram after it is created*, missing opportunities for reuse, access on demand and making it hard to share with geographically distributed team members.

One of our goals is to formalize the use of affinity diagramming for eliciting requirements and to further inform the design process. We believe there is utility in using an affinity diagram beyond the requirements phase and to guide the process of software development. To this end, we believe that affinity diagrams should be extended to include other design artifacts.

Although tool support for collaborative work processes such as affinity diagramming has increased, users seem to favor the use of traditional methods such as paper and whiteboard over software tools [17, 20]. This preference is usually more pronounced in early design work where creativity and flexibility is essential. Holtzblatt et al. [9] for instance, encourage participants to build affinity diagrams "on the wall, not in a tool" with a concern that tools would isolate participants, creating a barrier to communication which is necessary for the grouping and categorization process. Replacing a large workspace—such as a wall for

affinity diagramming—with a tool is also thought to restrict users to a pre-determined space such as a desktop instead of using any and all space available to them [12].

AFFINITY DIAGRAMMING WITH MDE

Affinity diagramming is particularly suitable for MDEs due to its collaborative and co-located nature. Creating an affinity diagram using an MDE will provide all the benefits of digitizing, with the added benefit of not being constrained to support multiple users at a single display. We believe an environment which includes a pixel-dense large screen display with interaction capabilities to support multiple users will be condusive for collaborative work like co-located software design and affinity diagramming. In this paper, we refer to such an environment as an MDE. The flexibility of using multiple varied devices in an MDE will not confine users solely to a traditional shared display.

In affinity diagramming it is critical to be able to pass locus of control seamlessly, have concurrent control or turn-taking techniques. If these interactions are not fluid, the tool will get in the way of users' interaction and communication, both of which are inherent in group work.

Sharing with distributed group members

Digitizing the diagram can eliminate, or at least minimize, the cost of printing hundreds of notes and multiple copies of the affinity diagram. Curtis et al. [6] describe constructing an affinity diagram with 1,800 Post-it notes and printing copies of diagrams for five distributed sites that used it. They point out the difficulty in sharing and maintaining such diagrams. Furthermore, a digital diagram affords easy sharing by removing the need for copying and transporting copies of the diagram among distributed design sites [12, 19].

Reuse and access on demand

Creating an affinity diagram in an MDE will enable the diagram to be saved and available for use in later phases of the software development lifecycle beyond the requirements gathering phase. A digital diagram can also be captured for reuse in future projects.

Currently affinity diagrams have to be taken off the wall after its creation mainly due to the use of a shared space or other constraints. However using MDEs, an affinity diagram can be saved and referred to by the team at any time during the software development lifecycle. The information will be available on demand. Hence the large shared display within the MDE can play the role of information radiator. Information radiators are commonly used in agile software development and typically "…display(s) information in a place where passersby can see it." [5]

Collaboration with team members

MDEs afford many benefits for small groups working together, among them the ability to "…place myriad information artifacts on shared displays for comparing, discussing, and reflecting on ideas…" [4]. The core idea behind affinity diagramming is affording discourse among participants as notes are placed on the diagram and groups are created.

MDEs are flexible in that they are comprised of personal and shared devices that form an integrated workspace [18]. The flexibility of using devices that already exist in the work environment (e.g. PDAs, laptops, large shared displays) makes MDEs a useful tool for collaboration and avoid overheads associated with setting up a work environment based on criteria such as layout and type of equipment. The inclusion of large shared displays in MDEs provides participants the opportunity to gather around the display and discuss ideas.

Fluid interaction and effective display of information

Research on interaction techniques especially for large shared displays further benefits MDEs and hence the process of affinity diagramming. Traditional interaction techniques for desktops such as mouse and keyboard might not be suitable for an MDE with multiple participants and a variety of devices. In the Center for Human Computer Interaction at Virginia Tech (CHCI), various interaction techniques for large shared displays are being researched e.g. [2] that can be applied to MDEs. Research on turn taking techniques e.g. [15] are also an important component that we plan to incorporate in our MDE.

MDEs that include wall-sized displays are pixel dense, which allows more information to be displayed and shared compared to regular large displays. In terms of affinity diagramming this translates to being able to create large affinities with a lot of notes. Wall sized displays also provide similar affordances as a wall, namely high visual bandwidth, ability for a group of people to simultaneously interact and contemplate, support group decisions, and to provide shared awareness of the activity.

BACKGROUND AND RELATED WORK

Currently there exist some tools for collaboratively creating affinity diagrams. GUNGEN [16] allows participants (collocated or otherwise) to use integrated PCs to organize notes into a hierarchy. CDTools [1] provides pre- and post-affinity diagramming support. The tool includes a database for recording raw customer data and transforming it into notes. Notes are then printed and an affinity diagram is created on a wall. After completion, the affinity diagram is re-entered into the tool by specifying the positions of each note and their labels. The Designers' Outpost [13] provides a tangible interface for interacting with sticky notes on a large screen display. The tool supports a history capture and retrieval system with three mechanisms for accessing design history [14]. A later addition extended the system to support distributed collaboration and introduced a gesture and presence awareness mechanism [7].

Our affinity diagramming tool will extend the work done in these current tool by supporting the creation of an affinity diagram on a large shared display. This diagram will then act as an information radiator for a co-located software development MDE.

MOTIVATION

We conducted four observational studies of participants creating affinity diagrams. The studies are described in more detail in Judge et al. [11]. The focus of these studies was to observe the collaborative work activity, dynamics of group decision-making, and to identify potential breakdowns during this process. These observational studies served as a pilot effort to observe breakdowns in the process of creating an affinity diagram that we will support with the development of a tool. We adapted the affinity diagramming process described by Holtzblatt et al. [9] in each of these sessions.

Method

All sessions were held in conference rooms with long tables in the center, a few chairs, and empty wall space on at least one of the walls. Participants were first given a brief overview of the study in the form of a handout explaining the process of creating an affinity diagram. Next the participants were introduced to a general. Among the topics were creating a shopping list for groceries, designing a remote control for senior citizens, and using a calendar management system. Participants then proceeded to build an affinity diagram.

KEY OBSERVATIONS

In this section, we discuss key observations from our study.

Shared awareness

In all groups, we observed a need for close physical proximity to the wall. Participants faced the wall for a significant amount of time while the remaining time was spent reading or organizing their individual notes. The notes on the wall drove conversations about creating clusters, placing notes, reorganizing clusters etc. Even though most participants did not stand in front of the wall at all times, they would pull up a chair or sit on the table facing the wall. *The importance of having a large shared workspace such as a wall in an MDE is essential as the essence of the affinity diagramming process lies in discussion about the notes and clusters.*

Our study also showed that participants had multiple foci of attention. Participants at times lost awareness of the activity on the wall while working on their individual notes. This would result in their not knowing about new clusters that were created, notes that were moved, or other activities taking place on the wall. In our observations losing such awareness negatively affected the group decision-making process. *Hence awareness of the workspace needs to be cultivated and maintained.*

Cognitive offloading

Participants engaged in cognitive offloading [10] by creating temporary labels for clusters and annotating notes. Temporary labels helped participants remember the main theme of a cluster and were created as soon as a cluster had a few notes. The labels kept evolving throughout the process as the clusters became more defined and eventually ended up driving the creation of actual labels once all the notes were on the wall. At times notes were annotated to preserve an idea a participant had about the note and were later used to create new sub-clusters. Therefore *support for the creation of temporary labels and for annotating notes should be provided.*

Understanding, Organizing, and Searching

Participants came up with many ways to understand and organize their individual notes. Among others, they put individual notes on a wall and referred to them as relevant clusters were created, organized them on the table or simply held their notes and worked one note at a time.

We also observed many instances where participants could not find particular notes or their duplicates. The most detrimental instance was when a participant remembered reading and adding a note to the wall, and then not finding that note when a related note was identified later. In most of these instances, the participant just gave up and stuck the note in a different cluster.

The ability to organize one's notes via a personal device and searching for notes should be supported.

RESEARCH QUESTIONS AND FUTURE WORK

Affinity diagramming as a tool for gathering requirements

Thus far, we have described affinity diagramming as an activity suitable for MDEs particularly from the shared large display point of view. However we are interested in taking affinity diagramming one step further by exploring the utility of using affinity diagramming for extracting more than just requirements but also to inform the design process. To accomplish this goal, we will be running a three month long study to test the utility of using our method of extracting requirements from an affinity diagram in a real world setting.

Information Radiator

We are investigating the utility of using an affinity diagram in an information radiator and the potential benefits it might provide software engineers who are performing co-located software development using MDEs [4]. Currently we have a prototype of an affinity diagramming tool using a wall sized display and PDAs (Figure 1). This display is a pixel dense wall-sized display that is becoming pervasive and more affordable. Once the tool is built and evaluated, our next step will be using the display as part of an MDE and evaluating the benefits it brings a co-located software development team.

Other issues

When building a tool to replace traditional paper and whiteboard methods, issues of scalability need to be addressed. For instance, how many affinity notes can a large shared display effectively support without participants losing shared awareness, what is an optimal number of users working together on one display? And even when an MDE has fluid interaction techniques, will the technology come in the way of collaboration, communication and

creativity? We plan to explore these issues once our tool is built.

Figure 1: Prototype of collaborative tool for creating affinity diagrams using a wall sized display and PDAs

CONCLUSION

In this paper, we have discussed the potential benefits of affinity diagramming in an MDE, namely the opportunity for sharing, reuse, access on demand, collaboration, fluid interaction and effective display of information.

We followed by discussing observational studies of affinity diagramming. These studies uncovered the importance of supporting shared awareness, cognitive offloading as well as understanding, organizing and searching within a tool that supports affinity diagramming.

We concluded by discussing our future work that focuses on exploring the possibility of using affinity diagrams as a tool for gathering requirements and in an information radiator in an MDE supporting co-located software development.

REFERENCE

1. InContext's Contextual Design Tools - cdTools, http://www.incontextdesign.com/cdtools/index.html. Last accessed September 2008.
2. Ball, R., DellaNoce, M., Ni, T., Quek, F., and North, C. Applying Embodied Interaction and Usability Engineering to Visualization on Large Displays. *ACM British HCI - Workshop on Visualization & Interaction*, (2006), 57-65.
3. Beyer, H., and Holtzblatt, K. *Contextual Design*. Morgan Kaufmann Publishers, 1998.
4. Biehl, J.T., Baker, W.T., Bailey, B.P., Tan, D.S., Inkpen, K. and Czerwinski, M. IMPROMPTU: A New Interaction Framework for Supporting Collaboration in Multiple Display Environments and Its Field Evaluation for Co-Located Software Development. *Proc. CHI*, (2008), ACM, 939-948.
5. Cockburn, A. *Agile Software Development: The Cooperative Game*. Addison-Wesley, 2007.
6. Curtis, P., Heiserman, T., Jobusch, D., Notess, M., Webb, J. Customer-Focused Design Data in a Large, Multi-Site Organization. *Proc. CHI '99*, ACM Press, (1999), 608-615.
7. Everitt, K.M., Klemmer, S. R., Lee, R., and Landay, J. A., Two worlds apart: bridging the gap between physical and virtual media for distributed design collaboration. *Proc. CHI '03*, (2003), 553-560.
8. Hailpern, J., Hinterbichler, E., Leppert, C., Cook, D., and Bailey, B.P. TEAM STORM: Demonstrating an Interaction Model for Working with Multiple Ideas During Creative Group Work. *Proc. C&C '07*, ACM Press, (2007), 193-202.
9. Holtzblatt, K., Wendell, J.B., and Wood S. *Rapid Contextual Design*. Morgan Kaufmann Publishers, 2005.
10. Hutchins, E. How a cockpit remembers its speeds. *Cognitive Science: A Multidiscplinary Journal*, (1995).
11. Judge, T., Pyla, P.S., McCrickard, D.S., and Harrison, S. Affinity Diagramming in Multiple Display Environments. *Technical Report TR-08-16*, Dept of Computer Science, Virginia Tech, (2008).
12. Klemmer, S., Farrell, R., Newman, M., Meza, R., and Landay, J. A. Tangible Evolution: System Architecture and Participatory Design. *Technical Report. UMI Order Number: CSD-00-1116,* University of California at Berkeley, (2002).
13. Klemmer, S.R., Newman, M.W., Farrell, R., Bilezikjian, M., and Landay, J.A. The Designers' Outpost: A Tangible Interface for Collaborative Web Site Design. *Proc. UIST 2001*, (2001), 1-10.
14. Klemmer, S.R., Thomsen, M., Phelps-Goodman, E., Lee, R., and Landay, J. A., Where do web sites come from?: capturing and interacting with design history. *Proc. CHI '02*, (2002), ACM, 1-8.
15. McKinlay, A., Procter, R., Masting, O., Woodburn, R..J. and Arnott, J.L., A study of turn-taking in a compter-supported group task. *Proc. HCI '93*, (1993), 383-394.
16. Munemori, J., Nagasawa Y. GUNGEN: Groupware for a new idea generation support system. *Information and Software Technology*, (1996), 213-220.
17. Newman, M.W., and Landay, J. A. Sitemaps, storyboards, and specifications: a sketch of Web site design practice. *Proc. Designing interactive Systems: Processes, Practices, Methods, and Techniques: DIS '00*, (2000), ACM, 263-274.
18. Stefik, M., Bobrow, D.G., Foster, G., Lanning S., and Tatar, D. WYSIWIS Revised: Early Experiences with Multiuser Interfaces. *ACM Transactions on Information Systems*, *5(2)*, (1987),147-167.
19. Wellner, P. Interacting with paper on the DigitalDesk. *Commun. ACM 36*, (1993), 87-96.
20. Whittaker, S., and Schwarz, H. Back to the future: pen and paper technology supports complex group coordination. *Proc. SIGCHI Conference on Human Factors in Computing Systems* (1995), ACM Press, 495-502.