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Idea Management In a Shared Drawing Tool

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Abstract

The generation of design ideas in group discussion is a complex and dynamic process. Some design ideas are accepted; others are rejected; many others are modified and combined. The fluent expression of ideas and the ability to interact and build on representations created by others contributes significantly to the idea generation process. Computerized shared drawing tools support this fluency and interaction, but such tools need to aid not only the drawing process but also the management of design ideas during group interaction. This paper lays the groundwork for the design of the idea management portion of a shared drawing tool. It presents a taxonomy of group idea management activities, identifies user requirements in support of these behaviours, and illustrates how the user requirements are satisfied by features in CaveDraw, an experimental shared drawing system.

1. Introduction

Because modern technology is complex, it is unusual for an individual to tackle the design of a major project single-handedly. Often, a small team is gathered at the initial stage of the design process introducing problems of organization, coordination and communication. Sketches are an important coordination tool for the shared design process and group communication. This group communication can be faciliated by computerized shared drawing tools which permit simultaneous sketching by team members in different locations. Although these shared drawing tools are exceedingly useful, we believe that the management of multiple inputs remains a significant issue in their design.

Observational studies have identified several critical factors in the design of shared drawing tools. These factors are derived from analyzing and interpreting collaborative workspace activities. Tang and Leifer (1988) point out that different workspace activities occur with different work mediums (e.g., whiteboard, private notebooks), different tasks (e.g., mechanics, architecture), and different time-scale problems (e.g., multi-year versus two-week projects).

We believe that understanding the group process of creating and manipulating task artifacts — sketches in a shared workspace — will allow us to identify user requirements in a shared drawing tool. We focus solely on group behaviours as members manage and manipulate design ideas and ignore variables like cohesiveness and prior design training. Akin (1979) shows that the more imaginative design alternatives and major design conflicts are often recognized while staring at sketches. We believe that supporting group behaviour in manipulating the sketches plays a central role in fostering this creativity. We note that Grudin (1989) has pointed out that lack of understanding of group behaviour is one of the reasons for groupware failure.

In this paper we are concerned with the design of tools that support idea management. Although no direct evidence exists to demonstrate that idea management is an important consideration in the design of shared drawing tools, we suspect this is an important issue based on empirical evidence from studies of individual designers using design aids. Ullman, Stauffer and Dietterich (1987) noted that in an individual design session, designers tended to forget some of the ideas they formulated. Yeomans (1982) discovered similar recall failures. Ullman et al. (1987) also found that a team of designers often worked at different levels of abstraction in their design, making it difficult to integrate the final products.

We also examine studies of group design that did not have the use of shared drawing tools. Rouse and Boff (1987) note the following group design behaviour:

> If an outside observer were to characterize designers' behaviors, particularly for complex domains such as aircraft design, it is quite likely that such an observer would conclude that chaos is the most appropriate characterization of design teams at work.

They explain the chaos as arising from different design philosophies that designers bring to a design team. Scheidel and Crowell (1964) describe group decision making as an idea-in-the-making process wherein one member suggests an idea, another modifies it and a third changes its focus until the final agreed upon solution unfolds. This process of cooperative work in the building of a group decision becomes too complex as more participants are involved. None of the above studies indicate that the outcomes of a design are affected by lack of idea management and no studies have been done on its use in shared drawing tools. However, throughout Section 3, we provide evidence from the literature that strongly suggests that the idea management criteria we propose is valid.

Design ideas are much more than sketches. They also embody task context, conversational exchanges, gestures and the order in which all of these take place. When we use the term "design idea" we loosely refer to the sketches actually laid out on the drawing surface. Thus, we focus on the tasks of choosing, comparing, and integrating multiple design sketches. We use these tasks to classify those areas

that would benefit from design idea management tools. We propose a set of user requirements for the design of multi-user shared drawing tools and illustrate the requirements in the design of a prototype, CaveDraw. CaveDraw is a shared tool running within a multi-media environment at the University of Toronto (Mantei, Baecker, Sellen, Buxton, Milligan & Wellman, 1991).

2. The Approach

To develop our user requirements, we studied videotapes of drawing space activities collected by various researchers. We have also drawn on prior research in engineering design studies, group communication and social psychology. We focused primarily on the interactions between collaborators as they manipulate current and previous design ideas. Our research plan is illustrated in Figure 1.

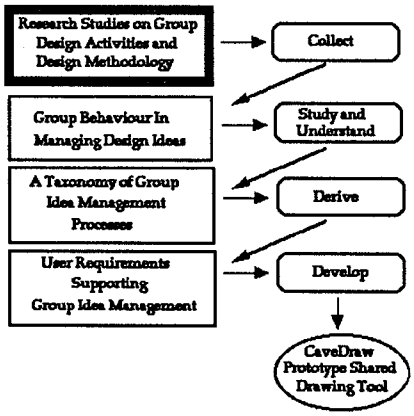

Figure 1. Research focus of this paper

Studying and understanding the scenarios of group behaviour in managing design ideas provides us with constraints on how a tool should be designed to support them. The scenarios presented in the taxonomy lead us to new insights into both shared drawing activity and user requirements for shared drawing tools.

3. A Taxonomy of Group Idea Management Processes

We present our analysis of the design study videos and previous research in the form of an idea management taxonomy. The taxonomy is primarily a listing of the more general levels of group interchanges and idea manipulation decisions made by group members. It is not exhaustive but covers the major behaviours we and others have observed in design activity.

Agree and add on to the suggested idea: A design idea is suggested. One or more collaborators make comments on the design either verbally or by sketching out the alternatives. Additional sketches are performed to further enhance the idea.

Tang (1989) observed this scenario in his studies; for example, one designer (S3) draws a representation of her design idea into the workspace, the other designer (S1) builds on the idea by adding keyhole slots. Tang (1989) points out

that this behaviour indicates that initial representations gradually evolve into distinct artifacts, often through modifications and additions made by others.

Agree and subdivide the suggested idea: A design idea is suggested. Participants agree on the idea as a start. They then proceed to break down the idea into sub-tasks or segments and work on them separately.

Breaking up a design idea into hierarchical sub-tasks is a general phenomenon seen in architectural and mechanical engineering design tasks. For instance, in the Office Design Project (Stults, 1988), the architects articulated a shared analysis of the client's needs, formed a concept (an overall design idea) in response to the needs, and summarized the issues (the sub-tasks) underlying the concept. Effective management requires that inter-relationships among solutions for each sub-task be laid out and saved by the group before the group commences work on the sub-tasks (Otto, Riley & Erdman, 1988).

Modify the suggested idea: A design idea is suggested. One or more participants modifies the idea by editing the sketches of the idea or by presenting additional related sketches. Participants may not be notified by others before their sketch is changed.

This scenario occurs in studies using Commune, a three-person shared drawing tool (Minneman & Bly, 1991). One of the participants erases one of the other participant's sketches without requesting prior permission for this action. We observed this in a private viewing of a Xerox PARC design session recorded on videotape. Such behaviour is also observed by Tang (1989). He points out that the change usually addresses a verbal criticism and such criticism often compromises the design idea. In studies of idea development in a small group meeting, Scheidel and Crowell (1964) describe how one idea is progressively remodified in group interaction until the group achieves agreement.

Modify, but preserve the suggested idea: A design idea is suggested, and participants suggest modifications that are distinct from the original idea. These changes can be removed if they don't appear to work.

Although we did not find this behaviour mentioned in the literature, we extrapolate its occurrence from our studies on shared writing (Posner, Baecker & Mantei, 1991). Both ForComment™ (Opper, 1988) and Word 4.0™ (Microsoft Corporation, 1989) permit this type of annotation in a document without the annotation affecting the original text. In the Office Design Project (Stults, 1988), one of the architects is observed to lay tracing paper on top of his tv monitor. Using another architect's sketch displayed on this monitor, he then proceeds to add his own idea on the tracing paper. The original sketch is preserved while the other architects comment on the new suggestion.

Scratch and restart: A design idea is suggested. One or more participants comment on the idea, and the originator admits that there is a problem with the design idea. The idea is discarded and the group searches for another design solution.

Tang (1989) calls this scenario "Admit Problem". He describes it as one of the negotiating patterns in encouraging the group to accept an idea. He notes that this

event often encourages others to help resolve the problem and share in developing the idea, but that some groups also use the admitted problem to reject the idea. In fact, the more ideas that members contribute, the more ideas the group will reject (Fisher, 1974). Fisher also points out that the period of idea testing during the conflict phase, involves the rejection of many idea proposals.

Suspend and wait: A design idea is suggested, and one or more participants make comments on the idea. Because the group is unsure about the suggested idea or because the idea is rejected out of hand, the discussion about it is dropped. The suggested idea can be forgotten or later reconsidered in an unrelated context (Tang, 1989).

In Fisher's (1970) study of decision modification processes in small groups, he observes group members introducing a particular decision proposal, discussing it for a length of time, dropping it in favour of another decision proposal and then, re-introducing it later during the group deliberations.

Agree and wait: A design idea is suggested and is well received. The group moves on to the next sub-task on the requirement list to complete the design. The suggested idea is put on hold until all design solutions for the overall design are gathered.

Once a global design idea is agreed upon by participants, it is further broken down into design sub-tasks, as mentioned in "Agree and subdivide the suggested idea". This scenario is shown in the MacViz-A design studies (Tang, 1989) when the participants listed their ideas, one after the other, on the shared workspace. The accepted idea was noted and the group moved on to solving the next design issue.

Compare and consolidate: Multiple design ideas for fulfilling the design requirement are suggested. The group compares and criticizes the solutions, and then consolidates them into one accepted version. In the consolidation process, several design solutions are aborted or modified at the same time.

Fisher (1974) notes from his studies that

> Group members usually focus their attention on various proposals during their interactions and choose from among those alternative proposals the ones which they will accept or reject. The sum of the proposals accepted constitutes the productivity of the group.

This type of activity has been observed to occur iteratively whenever a new design alternative arises during the design process.

Deprivatize design idea: After a design idea is generated, it is sometimes transferred from an individual workspace to a shared workspace.

In studies conducted by Tang and Leifer (1988), one participant was observed to begin drawing privately, producing a graphical object. Other participants noticed the object and began working on it. Tang and Leifer (1988) point out that the migration of this object from a private to a public object illustrates the dual public/private nature of the workspace.

We have identified nine distinct design sharing and modification processes that have been observed in group design. Naturally, the design process has additional complexities and subleties that we have failed to capture. Nevertheless, we believe that we have identified some of the primary behaviour patterns that groups apply

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