

# Supporting Collaboration in Creative Design

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## ABSTRACT

As design problems become more complex, there is an increasing need to build tools that support the intersection of collaboration, creativity, and design. Founded on design requirements taken from research in these three areas, we have created SCWID: a tool for Supporting Collaborative Work In Design. SCWID is a multiple-display, multiple-canvas system that enables effective creative groupwork in the early stages of design. The lessons we have learned throughout the development of this tool will help us to further improve SCWID and provide substantial benefit for the development of other collaborative design tools.

## KEYWORDS

Multiple-Display Environments, CSCW, Multiple-Device Interfaces, Creativity.

## CATEGORIES AND SUBJECT DESCRIPTORS

H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

## INTRODUCTION

Design problems are becoming increasingly complex, leading to an increasing demand for tools to support large-scale creative groupwork. As a result, existing tools are becoming less able to meet the changing needs of designers. There is a strong need to understand how to build tools to support collaborative design. To understand the design requirements for these tools, we did a thorough review of research in collaboration, creativity, and design theory.

Collaboration research shows the importance of building flexible software to support groupwork. Groups work in many different ways, and support for this breadth requires that an awareness of group members is provided [7], that individuals are able to transition between private and shared work [12], and that group members can generate and refine content together or separately [11].

Creativity research and design theory provide additional

lessons about the process of creative design. To support the creative process, a software tool should facilitate rapid content generation, evaluation, and structuring [11], access to multiple design ideas or variations at one time [4], and allow idea generation and refinement from any location [4].

Current tools address some of these requirements, but none adequately address all of them. Our contribution is a tool that better addresses this intersection of requirements. In this paper, we describe SCWID: a tool for Supporting Collaborative Work In Design. SCWID facilitates collaboration through the use of large displays (for shared views) and personal devices (for individual interactions). A sketch-based interface provides for rapid content generation, while a multiple canvas system provides rapid structuring of content and access to multiple design ideas as needed. Using SCWID, designers will be able to collaborate more effectively in the early stages of the design process, which is critical for developing effective solutions. We also report lessons learned throughout an iterative design process and functional prototype evaluation that others can draw upon when creating collaborative design tools.

## RELATED WORK

Current tools address some requirements for creative groupware, but none fully support all of them. For example, informal design tools (e.g. [1, 10]) facilitate rapid generation and structuring of content, but do not support collaboration or specific techniques for working with multiple ideas. Tools like Designers' Outpost [8] support collaboration, but not provide visualization of multiple, distinct ideas. Other tools employ interaction techniques to support working with multiple ideas [5], but they require group members to always work publicly and in the same location to generate and refine content. In contrast, SCWID incorporates a set of design goals informed by the intersection of research in collaboration, creativity, and design to achieve higher quality designs than current tools.

## SYSTEM DESCRIPTION

In this section we discuss the different features of our system that address the design requirements. Figure 1 shows two designers working on a complex design problem using SCWID.

### Large Displays and Personal Devices

In our system, a large display is attached to a server to provide a view of all of the work that is currently shared



**Figure 1. Two designers work together to create characters and storyboard a multimedia application. On the left, the two designers are working independently on different parts of the group design. On the right, a designer has zoomed in to add detail to a character design.**

(available for group viewing and editing) in the. This *global context* view allows groups to have a common point of reference for discussion and to keep work visible to everyone. For example, even if the group is currently divided to work on subtasks, each group member can stay abreast of the progress of the group and reinterpret design ideas, which is a key element of creative work [11].

Personal devices, such as Tablet PCs, are used to provide high-resolution, individually configurable displays for sketching content. A personal device can connect to the server to provide access to a small piece of the global context (a portion that the designer chooses to zoom in on) to allow the designer to focus in on the current task without added visual distractions or lessened screen space for the current task. Of course, the global context is available at a glance on the large display when needed. This differs from tools like CoLab [13] by allowing a designer to sketch details without losing their view of the surrounding content.

To facilitate awareness of what other users are working on, each user is associated with a colored rectangle in the global context (shown on the large display). The rectangle encompasses the user's current view on the personal device. When two users are viewing the same canvases, their views may overlap. In that case they can see the other user's rectangle on their personal display as well. This allows them to coordinate and avoid unintentional overlap in work.

### Multiple Design Ideas

SCWID provides multiple sketching canvases that exist in the "global context" and can be arranged visually to accommodate the needs of the group. Multiple canvases provide an inherent structuring of content by providing independent objects. This provides simple means for common activities such as comparing and contrasting design ideas by simply moving and resizing them on the large display for group discussion. Different combinations can then be easily placed side by side while other canvases are moved out of the way so that they can be available for reference without taking significant portions of the space.

SCWID also provides special canvases that are not visible in the global context. These private canvases can only be accessed on the personal device of the "owner" of that private canvas. This provides for a designer's need to do work that is not shared: the work will not be viewed until it is ready, inadvertently altered by other group members, or clutter the workspace if it is only valuable for the owner. Canvases can be readily moved back and forth between private and shared modes to accommodate information's changing role in groupwork.

### Sketching Interface

SCWID includes a sketching interface that allows designers to quickly externalize thoughts, allowing for visualization, communication, and external storage of ideas. Sketching also provides a level of ambiguity that facilitates reinterpretation of different thoughts [11].

### Navigation Controls

As a personal device displays only a portion of the global context, a *navigation widget* is provided to allow the user to pan and zoom within the current canvas so that they can access the appropriate areas to continue their work. This also allows them to get a closer view of another group member's work in the same canvas by panning and zooming to include their view.

While this provides useful navigation within a canvas, moving from one canvas to another can become problematic when, in the global context, the canvases are relatively far apart or even overlapping. A *navigation map* resides on the toolbar above the navigation widget to provide both a miniature view of the global context and to allow discrete navigation among canvases. A single click on a canvas in the navigation map will navigate to the user's last view in that canvas. A circle gesture within a canvas will navigate to a new view that encompasses the area circled.

### Remote Control of Large Display Content

The personal device can also switch to an *interactive map* mode to allow manipulation of the global context. The

personal device shows a smaller version of the large display where the user can select canvases to move and resize. When canvases are moved and resized, these actions are mirrored on the large display and in the navigation maps of the other group members' personal devices. If a canvas is moved so that it obscures another canvas (by overlapping it), this will not affect the view on any personal devices because the personal device provides a view into a canvas rather than a part of the frame buffer shown on the large display. This also means that resizing or moving a canvas that another group member is currently working in will not affect their work in any. We left these controls relatively unsecured so that designers would not be constrained in what they can do and social convention can be used to avoid difficulties.

## IMPLEMENTATION

To support different hardware configurations, SCWID is designed with a client-server architecture to allow the software to be run on multiple machines through TCP connections, on the same machine with multiple monitors (using local TCP connections), or as a standalone client. Virtually any large display can be used for the shared context or, if no large display is available, the tool can still provide many benefits to a designer.

To allow for operating system portability, SCWID is written with Java 1.5 using the Piccolo zoomable user interface toolkit [2]. This allows designers to use any computer that supports a Java runtime environment.

This flexibility means that designers are able to work with whatever hardware, operating system, or network configuration is available. Design groups can also readily do work individually and later share it with the group. Designers can even connect remotely and still have access to shared work and share their own work with the group.

## ITERATIVE DESIGN AND EVALUATION

To develop SCWID, we followed an iterative design process [9]. This process included the creation and evaluation of various paper prototypes followed by the creation and evaluation of a functional prototype. The iterative design process leading up to the functional prototype has been described previously [3]. We focus here on the evaluation of our functional prototype and the key lessons learned throughout the entire process.

### Evaluation

We asked three groups of users to make use of our functional prototype and provide us with feedback. The groups consisted of two or three individuals that had worked together on creative tasks in the past and each had at least one year of design experience. We demonstrated the capabilities of the tool and then asked the group to use the tool to create a comic strip. This task was chosen because it could be done in a relatively short time, but was also highly creative and group oriented, making use of different design ideas, coordination to perform subtasks, and bringing

together the work of individual group members to form a final collective result. In our instructions, we purposely left the process up to the group. After the tasks were complete, we asked follow-up questions and solicited comments.

The results of our study were generally positive. Our overall best response was to questions about how well SCWID supports multiple people working together to accomplish a goal. This result was especially interesting because the groups divided the work in very different ways, from working completely independently on subtasks to drawing strokes on the same sketch at the same time. However, in every case, the system was able to provide enough information for the groups to coordinate their actions. On the other hand, our overall worst response was to questions about how well SCWID supports the rapid exploration of different ideas and variations on a single idea. Designers felt that the basic functionality should be improved to encourage them to quickly generate new ideas that were based on current designs.

### Lessons learned

Throughout the evaluations of our iterative design process, we learned that collaborative design tools should:

- *Minimize errors that could affect other users.* When a user makes an error that changes the shared context, it could have a significant impact on other users. In our studies we found that users would sometimes make mistakes in the system that would lead to large changes in the shared context, such as dramatic rearrangements of canvas positions or closing a canvas. Though there are several ways that such errors could be minimized or their effects mitigated, we chose to separate the global controls from the local controls by moving them to a “map view” screen that had to be specifically accessed. This forced users to realize they had switched to a different mode and that their actions would now affect the shared context without unduly hampering their movements with confirmation messages or the like.
- *Lay out canvases according to a “windows” metaphor.* In a multiple canvas system, one challenge is determining how to best lay out the canvases. One option is to split the shared workspace so that each canvas is laid out in a grid. When they need to be repositioned, the surrounding canvases could automatically move and resize to account for the change. Our users always wanted to have immediate access to every shared canvas. However, they also wanted to structure the space themselves. Based on the responses, we use a window style layout and allow the users to structure the space so that important information was visible. However, we also allow navigation to an obscured canvas so that all of the information is still accessible.
- *Provide a means of connecting canvases together.* Rapid exploration of design ideas requires that designers be able to explore many different variations of an idea quickly and that inspiration can be drawn from many sources,

including the ideas of other group members. With single-user tools, such as Photoshop, designers often address this need by using different layers to explore different variations. Lack of support for such activities turned out to be a weakness of SCWID. We are addressing this issue by allowing canvases to be linked both strongly (a change in canvas one is reflected in canvas two - similar to layers) and weakly (changes in one do not affect the other, but an association is maintained to link the canvases for the designer's reference). These two abilities will allow designers to quickly explore variations of an idea and note conceptual connections between ideas for later comparison.

- *Include splitting and merging functions for canvases.* The designers in our study often worked on several design ideas within a single canvas or different pieces of a single design across multiple canvases. Inevitably, the designers needed to split one canvas into several or merge several canvases into one. Using traditional cut, copy, and paste functionality, a designer could “split” or “merge” a canvas, the designers thought of these as single actions. To address this issue, we will provide built-in methods for splitting and merging canvases. To split a canvas in two, a designer need only select the part that will be moved and click the “split” button. To merge two canvases, a designer need only select the appropriate canvases and click the “merge” button. The new canvas will include the strokes from the newly merged canvases placed according to their relative positioning before the merge.
- *Balance awareness against distraction in visual cues.* We found that a rectangle showing where each group member is currently working enabled coordination and communication. However, the designers were repeatedly distracted by the sudden appearance of a visual cue that another group member had navigated into their view. The designers were also distracted when a stroke drawn by another group member would appear suddenly in their view. Though this is not a new type of problem [6], it has not been addressed for this domain. We are addressing this issue by having cues and strokes fade into view instead of appearing suddenly. We believe this will provide adequate awareness with less distraction.

#### **CONCLUSION AND FUTURE WORK**

SCWID was designed to support collaborative groupware by combining the affordances of large and small displays while following a strict set of design goals derived from both collaboration research and creativity research. By addressing these design goals, we have provided a tool that can foster creative groupwork in ways that other tools do not. A usability test showed that SCWID provides a solid benefit to designers, but still has a few key issues left to address. Our future work is to evaluate the tool against current groupware tools to determine for which scenarios tools like SCWID are the appropriate solution.

#### **REFERENCES**

1. Bailey, B.P., J.A. Konstan and J.V. Carlis. Demais: Designing Multimedia Applications with Interactive Storyboards. In *Proceedings of ACM Multimedia*, 2001, 241-250.
2. Bederson, B.B., J. Grosjean and J. Meyer. Toolkit Design for Interactive Structured Graphics. *IEEE Transactions on Software Engineering*, 2003.
3. Cook, D.J., H.E. Metcalf and B.P. Bailey. Scwid: A Tool for Supporting Creative Work in Design. University of Illinois at Urbana-Champaign, Technical Report UIUCDCS-R-2005-2556, 2005.
4. Gabora, L. Cognitive Mechanisms Underlying the Creative Process. In *Proceedings of the ACM Conference on Creativity & Cognition*, 2002.
5. Guimbretière, F., M. Stone and T. Winograd. Fluid Interaction with High-Resolution Wall-Size Displays. In *Proceedings of UIST*, 2001, 21-30.
6. Gutwin, C. and S. Greenberg. Design for Individuals, Design for Groups: Tradeoffs between Power and Workspace Awareness In *Proceedings of CSCW*, 1998 207-216
7. Gutwin, C. and S. Greenberg. Effects of Awareness Support on Groupware Usability In *Proceedings of CHI*, 1998 511-518
8. Klemmer, S.R., M.W. Newman, R. Farrell, M. Bilezikjian and J.A. Landay. The Designers' Outpost: A Tangible Interface for Collaborative Web Site Design. In *Proceedings of UIST*, 2001, 1-10.
9. Lewis, C. and J. Rieman. *Task-Centered User Interface Design*, 1993.
10. Lin, J., M.W. Newman, J.I. Hong and J.A. Landay. Denim: Finding a Tighter Fit between Tools and Practice for Web Site Design. In *Proceedings of CHI*, 2000, 510-517.
11. Lugt, R.v.d. How Sketching Can Affect the Idea Generation Process in Design Group Meetings. *Design Studies*, 2005.
12. Shen, C., K. Everitt and K. Ryall. Ubitable: Impromptu Face-Toface Collaboration on Horizontal Interactive Surfaces. In *Proceedings of the ACM Conference on Ubiquitous Computing*, 2003.
13. Stefik, M., D.G. Bobrow, S. Lanning, D. Tatar and G. Foster. Wysiwiw Revised: Early Experiences with Multi-User Interfaces In *Proceedings of CSCW*, 1986 276-290

#### **CONTRIBUTIONS AND BENEFITS STATEMENT**

We present a tool that facilitates creative groupwork. We also discuss an evaluation of the work and provide lessons that will benefit other collaborative design tools.