SCWID: A Tool for Supporting Creative Work In Design

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ABSTRACT
Computer tools offer enormous benefits for the early design process such as remote collaboration, advanced visualization, and the ability to run a design. However, current tools fail to support many elements of creative problem solving, inhibiting the early design process. From the literature on design theory and creativity, and extensive low-fidelity prototyping, we developed SCWID: a tool for Supporting Creative Work In Design. SCWID uses a large display to provide a shared visual context for alternative design ideas and multiple local displays for sketching details, navigating a particular idea, and manipulating alternatives. Grounded in creativity theory, the use of our tool facilitates creative thinking in the early stages of design for individual and groups of designers.

Keywords: Multiple-Display Environments, CSCW, Multiple-Device Interfaces, Creativity, Design

INTRODUCTION
Computer tools can provide many benefits for the early design process. However, if a tool does not adequately support the process of creative thinking in the early stages of design, it can disrupt that process and inadvertently lower the quality of a designer's final product or raise the cost of creating it.

A review of creativity research shows that, in order to support the continuous cycle of idea generation, evaluation, and refinement that compose the creative problem solving process, tools must effectively support at least the following five design goals:

- *Sketching and structuring*. Sketching and structuring aids (e.g. storyboards) provide many benefits for designers such as allowing them to effectively and efficiently externalize, reinterpret, and communicate design ideas [9].
- *Rapid experimentation within the design space*. A designer is more likely to produce a creative final design when enabled to quickly explore large numbers of design possibilities and refine designs along different dimensions relevant to the domain [6].
- *Working with multiple design ideas in parallel*. Viewing and arranging design possibilities in parallel allows designers to synthesize many existing ideas via comparing and contrasting as well as to create new ideas based on inspiration from past or alternate design ideas [5].
- *Collaboration*. To support effective and creative group work processes, a system must provide designers with group awareness and the ability to work both publicly and privately [9].
- *Reflection and "anywhere" refinement*. Because refining a design idea typically involves periods of reflection (examination of a specific idea and alternatives) and incubation (background thinking about the idea) which can occur in many different settings, a tool should provide flexibility in location [5].

Current tools support different properties of the creative process to various degrees, but none fully support them all. For example, tools such as DEMAIS [2], provide sketch-based interfaces and storyboarding, but do not support collaboration or specific techniques for working with multiple ideas. Other tools employ interaction techniques to support working with multiple ideas [7], but they force designers to stand, reach, and physically move about the display. When tools better support different aspects of the creative process, they can result in more effective designs [1].

ITERATIVE DESIGN
To address these needs, we created SCWID: A tool for Supporting Creative Work In Design. The basic configuration is a distributed display workspace where a server with a large display shows shared visual (global) context of all the design ideas while private client displays allow designers to independently sketch details, navigate (pan and zoom) within a specific idea, or switch to an alternative idea. To provide structuring of the idea space, each design idea is represented on a zoomable drawing canvas, and each canvas is independent, moveable, and resizable such that canvases can be rearranged within the global context.

With this initial idea, we developed SCWID through an iterative design process [8] including three rounds of low-fidelity evaluations. Among other lessons, these evaluations showed that:

- *Controls for navigation between canvases should be distinct from controls for navigation within a canvas.* Users found our control widget useful for navigating within a

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canvas, but did not consider it appropriate for navigating between different canvases. Rather, they wanted a discrete interaction to move to another canvas. To address this, we provided a "map view" that allows single-click navigation to a different canvas.

- *Tools should allow for personal territory within the global context.* Initially we laid out loaded canvases in rows based on the order that they were loaded. However, users reasoned that if they loaded a canvas, it should appear near where they were sitting. We addressed this by allowing a user to select the initial location.
- *Users should not be allowed to do hidden work within canvases over which they do not have sole ownership.* Our users were extremely against our initial method of allowing private work, in which a collaborator could affect a shared area in a way that was not visible to other group members. This was addressed by providing private canvases and quick methods for copying and pasting groups of strokes between canvases, both private and shared.

Based on our design goals, the lessons we learned from low-fidelity evaluations, and lessons taken from the evaluations of other tools, we implemented a functional prototype.

SYSTEM DESCRIPTION

In the prototype, each client divides the screen into two main sections: the sketching area and the local controls toolbar. Building on our earlier work [4], the sketching area on the private display provides a detailed view into a specific canvas which can be panned and zoomed. This sketch area is surrounded by a border with the user's unique color. For each private display, there is a corresponding colored rectangle (frame of reference) shown within a particular design idea on the server's large display. This shows the viewing relationship between the private display and the context of a particular design idea while providing group awareness. If a designer views a different design idea, the frame of reference would then be shown within that idea.

The right side of the client screen contains a local controls toolbar for general user interactions including a file menu, a navigation widget, and buttons for common editing tasks to allow a designer to quickly draw different pieces from different designs to form a new one. The local controls toolbar also allows the user to switch the cursor between sketching and selection mode. The toolbar provides access to different canvases by listing those available and providing a map view of the global context. When selected, the map view covers the client and mirrors the view of the large display to allow for manipulating canvases. A separate toolbar within the map allows a user to control the global context and navigate quickly to a specific area of a canvas.

IMPLEMENTATION

Our system is designed to benefit designers with any computer hardware available and that are working either individually or in a group. To support this flexibility, the system allows for nearly any hardware configuration, operating system use, or network connections.

To support different hardware configurations, the tool 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.

SCWID supports designers regardless of input device. Though designed for maximum effect with a stylus for sketching and a 6DOF device for navigation, the tool works just as well with only a mouse. Keyboard shortcuts are provided for some functions, but are neither required nor a significant factor in the design of the system.

To allow for operating system portability, SCWID is written with Java 1.5 using the Piccolo zoomable user interface toolkit [3]. This allows designers to use any computer that supports a Java runtime environment, which, with further development will include handheld and other small devices.

This flexibility also allows for the benefits of the system to be available with any network, whether wired or wireless. This allows groups of designers to form ad-hoc networks in any location with a large display.

Add this flexibility to the general creativity principles inherent in the design and we are excited about the benefits we can provide to a very wide range of designers.

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