A Separated Focus+Context Screens System for Sketching

Mark Flider  
Department of Computer Science  
University of Illinois at Urbana-Champaign  
mflider@uiuc.edu

Brian P. Bailey  
Department of Computer Science  
University of Illinois at Urbana-Champaign  
bpbailey@uiuc.edu

ABSTRACT  
Designers need a larger electronic workspace effective for sketching. To provide such a workspace, we have developed a focus+context screens system which tethers a smaller ‘focus’ screen to a larger ‘context’ screen. For increased performance and a more naturalistic interaction, we also split the input into sketching with the dominant hand and control with the non-dominant hand. We compare the differences between design work using current systems and our system. Our results and recommendations should help systems designers develop more effective separated focus+context screens systems.

Author Keywords  
Design, Focus+context, Sketching, Two-handed interaction.

ACM Classification Keywords  
H.5.2. Information Interfaces and Presentation (e.g., HCI): User Interfaces.

INTRODUCTION  
Designers need a larger electronic workspace effective for sketching [1]. To be effective for sketching, we believe a larger electronic workspace should enable a designer to sketch on a high-resolution screen in an ergonomic and familiar manner, quickly and accurately navigate to different parts of a design, sketch details in context of the broader design, and instantaneously switch between a detailed portion of a design and its context.

To satisfy these requirements, we could use a visualization technique such as zooming [3] or a distortion-based view [4, 6, 12], or use a single large screen [5]. While each of these techniques meets some of our requirements, none of them meet all of our requirements. For example, a zooming canvas does not enable a designer to sketch details in context of the broader design and the use of a single large screen provides poor ergonomics [5].

To create a larger electronic workspace that meets our requirements, we developed a focus+context screens system in which we tethered a high-resolution tablet to a large screen. As shown in Figure 1, the tablet provides a logical frame of reference into the content shown on the large screen.

In contrast to the focus+context screens system developed by Baudisch [2], we physically separate the focus screen from the context screen to provide a designer with a more ergonomic context view while sketching. We position the large screen just above and behind the tablet to ensure that the tablet does not block the view of the context. Since our focus screen is tied to, but physically separated from its logical frame of reference, we also gain the ability to scale the focus and context views independently.

Consistent with bimanual theory [7, 9], we enable a designer to control a focus+context screens system using a 6DOF input device in her non-dominant (ND) hand while sketching with her dominant hand.

We show how the use of our focus+context screens system overcomes the limitations of existing systems; by separating the focus and context displays into large and small screens, each screen can complement the other, creating a system
more effective than its component parts. Our system allows a
designer increased performance and more naturalistic input,
providing him with a more effective electronic workspace
for sketching.

A focus+context screens system such as ours would be use-
ful for a wide variety of sketching applications; annotations
in graphs or charts, multimedia interactions using a visual
sketching language, and industrial or mechanical design, where
mathematical curves can be mixed with rough sketching for
color and shading, are just a few examples.

RELATED WORK
Our work differs from previous work in that we are using a
focus+context screens system to provide a larger electronic
workspace effective for sketching, and using a ND hand in-
put device for control.

Larger Electronic Workspaces
To provide a virtually larger workspace, we could use a zoom-
ing canvas [3], but this does not enable a designer to view
details in context of the broader design [2]. Distortion-based
views [4, 6] have been effective for visualizing large amounts
of information, but the inherent spatial distortion involved
would be awkward and inappropriate for visual design tasks
such as sketching.

To provide a physically larger workspace, we could use a
large digital desk. A large digital desk, however, typically
has poor resolution, is not well-suited for users under 5’6”,
is not ergonomic, suffers from parallax effects, and users do
not prefer it to a tablet for sketching [5].

Previous systems which tied smaller displays to a large dis-
play [13, 14] either did not support or were not designed
for sketching. Baudisch et al. surrounded a high-resolution
small screen with a lower-resolution large screen [2]. Since
the screens lie in the same plane, however, a designer would
need to sit very close to the screens to sketch, overly limiting
her visual angle to see design context.

Control Techniques
Photoshop’s navigator implements a focus+context screen
by providing an additional, smaller window. This competes
for screen space, a precious commodity to designers [10].
Unlike our system, it does not allow the context view itself
to be manipulated and there is ostensibly little empirical jus-
tification for this particular configuration of view and map-
ing. Most importantly, in our system, we allow a designer
a more natural environment by enabling her to control the
focus+context screens system using her ND hand.

Buxton has shown that two-handed interaction can enable
faster performance for drawing and other tasks [9]. In our
work, we investigate two-handed interaction for controlling
a focus+context screens system.

FOCUS+CONTEXT SCREENS SYSTEM
To provide focus+context, we tethered a high-resolution tablet
to a lower-resolution large screen where the tablet, i.e., the
focus screen, provides a frame of reference into the context
screen (see Figure 1). With our focus+context screens sys-
tem, a designer can use the tablet for sketching and can use
the larger screen to see design context.

On the context screen, we draw a frame of reference to en-
able a designer to quickly identify their location in the con-
text. The focus screen shows details of the design lying
within the frame of reference. We draw the frame of ref-
ERENCE on the context screen using a red rectangle, as shown
in Figure 1 (it appears dark grey if printed in greyscale).

Separated Displays
Designers traditionally prefer paper to computers for sketch-
ing, since paper affords a very tactile, high-resolution sur-
face and is the de facto model for pencil or pen strokes. To
mimic this interaction as closely as possible, we use a Wa-
com Cintiq 18SX graphics display tablet. The Cintiq allows
a designer to sketch directly on the surface of the tablet with
very high resolution and sensitivity, as well as the freedom
to move, pivot, and reposition the display itself.

For the context screen, we use a NEC LT260 high-lumen
projector to project a large screen on the wall. We position
the focus screen on a desk a few feet away from the projected
screen and horizontally center the focus screen with respect
to the projected screen.

Our approach is similar to Baudisch’s [2], except that we
physically separate the two displays to afford a wider visual
angle of the context screen, which is important for improving
spatial performance. To drive the focus and projected screen,
we use a Macintosh computer with a dual head graphics
card. We wrote the software for our focus+context screens
system using Objective-C and Cocoa under Mac OS X.

Non-dominant Hand Input
Consistent with theories of bimanual input [7], we enable
a designer to control the information shown on the focus
screen using her non-dominant (ND) hand while sketching
using a stylus in her dominant hand as shown in Figure 1.
Buxton has shown that a two-handed interaction consistent
with bimanual theory can provide better performance on draw-
ing tasks than a single-handed interaction [9].

For our input device, we selected 3D Connexion’s Cadman,
a 6DOF isometric input device, which we refer to as a “puck.”
We chose this device because Jacob and Sibert recommend
that an input device used for panning and zooming should
enable a designer to perform these tasks in parallel [8], which
our puck does.
When a designer sketches on a physical sheet of paper, he uses his ND hand to position the paper, and his dominant hand to draw and erase strokes. We wanted to mirror this familiar, naturalistic interaction as closely as possible, but still allow additional controls (such as zooming) that are useful in an electronic medium.

**COMPARISON WITH CURRENT SYSTEMS**

In order to compare our focus+context screens system with existing systems, we have chosen a task that is typical of designers working with electronic workspaces. Our designer wants to add detail to the right eye of the face in Figure 2, using the context to position it correctly relative to the other eye, mimic the existing style, and add emotion which fits the rest of the face. This could be useful, for example, when creating or animating an interactive game character.

**Electronic Workspaces**

Let us compare the workflow using pencil and paper, a zoomable interface, a fisheye view, a traditional focus+context screen display, and our separated focus+context screens display, to show how our system provides a more effective sketching environment than the other tools.

- **Pencil and paper.** To add detail to a portion of a drawing, a designer simply focuses her attention on the area of interest, and proceeds to sketch. To look at the broader design she need only glance up or tilt back her head, without needing to lift her pencil. Paper, however, does not support “undo”, nor does it allow for animation, multimedia, or distance collaboration.

- **Zoomable interfaces**, such as Pad++ [3], allow a designer to “zoom into” an area of focus. In order to view the broader design, however, a designer needs to switch his entire display to a different zoom factor. Thus, our designer is forced to choose between editing the details of the eye and viewing the overall context of the face, as shown in Figure 2.

- **Fisheye view.** Since a fisheye view shows surrounding details in addition to the area of interest [6], it forces a competition for screen space to balance the focus and context. Increasing space for the context limits the allowable sketching region, a precious commodity, but increasing the focus space detracts from the design’s context. Additionally, the fisheye view warps the design significantly (see Figure 3). This is ineffective for our sketching task, where precise layout and structure are crucial to the visual understanding of a design.

- **Integrated Focus+context screen.** Baudisch’s focus+context screen puts both displays on the same plane in physical space [2]. The high-resolution focus display is ideal for sketching tasks while up close, but in order to see the broader context, a designer must physically step back away from the display, due to its size (see Figure 4). Thus, the switch from detailed sketching to examining context could take a significant amount of time and effort.

- **Separated focus+context screens.** In our system, the designer is allowed the freedom of sketching along the entire surface of the focus view. With a glance upward, she can see the focus view in relation to the undistorted broader context of her design on the larger context screen (see Figure 5). This enables her to maximize time spent on a task while minimizing interaction effort.

**Control Techniques**

We compare various control techniques to our actual implementation of a 6DOF input device:
Stylus with modes. Most design tools today require the designer to switch tool modes – via a keypress or by holding down a button – to toggle input between sketching and control. Greater performance and satisfaction could be obtained by exploiting a ND hand’s movement and its naturalistic “framing” of the sketching space [9].

Mouse with scroll-wheel. We originally implemented our system using a mouse to position the virtual canvas, and the mouse’s scroll wheel to zoom or scale content on the focus screen. Preliminary tests showed users found the one-to-one mapping of the mouse frustrating and tiring, especially for large movements which required repeated motions and picking up the mouse.

Accelerometers. A designer could use the movement and tilt of the focus screen itself to control the display through accelerometers. While effective for palm-sized devices [11], the size and weight of the Cintiq we used was quickly determined to be ineffective for this type of control, inhibiting fine adjustments and limiting on-screen interactions to large, jerky movements.

6DOF Device. A 6DOF device in the designer’s ND hand allows each axis of movement and rotation to be mapped to a different control: for example, twisting the puck could zoom in and out of a design. The dominant hand is free to sketch without a modal interruption while the ND hand smoothly controls the design. This parallels the naturalistic interaction afforded by pencil and paper.

FUTURE WORK
We are in the process of evaluating different configurations of input mappings to determine the highest performing and most satisfactory. Additionally, we would like to confirm our design rationale through a formal comparison between a separated focus+context screens system, Baudisch’s focus+context screen, and a zoom-able interface such as Pad++.

In our current implementation, we tie the designer’s ND hand to the focus view on the projected display (the red rectangle in Figure 1): when the designer pushes left, the red rectangle moves left. This makes sense when looking at the projected display, but if the designer looks at the focus display while pushing left, he sees the design move to the right. We are currently investigating input configurations in an attempt to resolve this discrepancy of motion.

REFERENCES


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