Clear Panels: A Technique to Design Mobile Application Interactivity

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ABSTRACT

We introduce a design technique, *Clear Panels*, to design interactive mobile device applications. Using mixed-fidelity prototyping, a combination of low- and high-tech materials, participants refine multiple aspects of a mobile application's design. *Clear Panels* supports writing and sketching via a transparent overlay affixed atop a mobile device screen. It enables design partners to refine their gesture-based interactions on actual devices. The technique has been successfully implemented in the design of children's mobile applications. The technique leverages and extends longstanding interaction design methods to include mobile and hand-held technologies. Importantly, we show it is effective in raising participants' awareness of key mobile application design issues without constraining their creativity.

ACM Classification Keywords

H.5.2 [User Interfaces] Prototyping, Input devices and strategies

INTRODUCTION

The ubiquity of mobile devices in today's society coupled with the growing number of children who are digital natives [1] underscores the need for design methods to address the creation of mobile device applications for young children. Participatory design approaches have been used for decades to design desktop applications that rely on traditional interaction technologies such as mouse or keyboard input, and large displays [8, 10]. However, existing methods and techniques transfer inadequately to the design of mobile applications due to constraints, such as small sizes, and affordances, such as portability and location awareness [4, 10, 14]. Further, as mobile technologies shift from stylus and graffiti-based inputs towards touch and gesture-based inputs, new interaction modes must be incorporated into mobile applications.

Figure 1 Using the *Clear Panels* design technique with children

Participatory design methods involving children (aged 4-12) have been used worldwide to design novel technologies [2, 3]. However, child design partners, who may be digital natives but not expert mobile device users, can benefit from new methods that support children's understanding of affordances and constraints associated with the mobile environment.

The *Clear Panels* technique has its roots in mixed-fidelity prototyping [7, 12]. The technique employs a combination of high-tech mobile application prototypes and a clear panel for low-tech sketching (Figure 1), and focuses on incorporating attributes specific to mobile devices into the participatory design process. The use of the low-tech clear plastic panel affixed to the high-tech mobile device prototype enables designers to authentically maintain the affordances, such as mobility, of the mobile device and remain in context with the actual device in a way that an inauthentic replica, such as a wooden block, would not.

We have found that *Clear Panels* aids design partners, specifically children, in refining the design of several facets of mobile device applications. We employ actual devices rather than mock-ups or low-tech prototypes, to enable design partners of all ages to experience the actual weight, screen size, and interaction of a mobile device rather than use a simulated or artificial interaction.

RELATED WORK

The use of prototyping as an activity, as opposed to prototypes as artifacts, help designers traverse design spaces [6]. One affordance of prototyping is that the incompleteness of prototypes enables designers to explore different design options for user interaction and application tasks. Thus the prototype as a filter supports the redesign of specific aspects of an application's design [6]. For example, to discover whether or not a device's design enables comfortable holding, as in a camera, designers may create multiple models of the camera to determine which ones are preferred by users.

In addition to the notion of a prototype as a design filter, prototypes can also be described in terms of the fidelity of the materials used. In broad terms, low-tech prototypes are commonly characterized by the use of paper or other non-digital materials as prototyping materials [9, 13, 14]. In contrast, high-tech prototypes are commonly characterized by the use of digital media as the basis for the prototypes [13]. Thus, the concept of mixed-fidelity prototyping involves the use of a combination of low-tech and high-tech prototypes used together [7, 8].

Recent studies have investigated the specific challenges of designing mobile device applications by adapting and extending existing techniques and methods to maintain close fidelity to mobile attributes. For example, de Sa, Carrico, Duarte, and Reis created a software framework to enable designers to digitally customize hand drawn sketches of mobile application interfaces [12]. Svanes and Seland apply role-playing and low-fidelity prototyping methods in the design of new mobile technologies for healthcare workers [14]. However, none of these studies involved children in the design process; our approach developed by partnering with children aged 8-12. One new approach, Layered Elaboration, does make use of transparencies with children as design partners; however, it does not affix the material to a high-tech artifact, but uses it as a layered low-tech storyboard [16].

CLEAR PANELS TECHNIQUE

Clear Panels is a mixed-fidelity prototyping technique to provide designers of all ages, but specifically those between 8-12 years old, with a means to consider the constraints and affordances of mobile devices in their designs.

Early-stage idea generation occurs prior to using *Clear Panels*. The initial design can be accomplished through any number of design techniques, including storyboarding [14, 15] or low-tech prototyping [11, 13]. The technique used to derive the initial design idea can be left to the discretion of the designer or this stage may be omitted depending on design requirements.

An application prototype should be developed from the design ideas. Using the prototype, the *Clear Panels* technique can be used to create and refine gesture-based interactions. The prototype should be as incomplete as possible to provide the design partners a sufficient amount of the design space to explore.

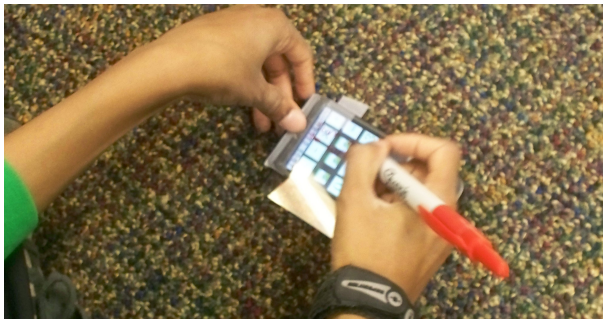

Figure 2 Mobile prototype & transparent overlay for sketching with Clear Panels Design Technique

Each design partner is provided with a mobile device, a clear panel, and a permanent marker. The clear panels are pieces of acetate cut to the dimensions of the device interface (screen). Each panel is then temporarily affixed to the mobile device creating a low-tech drawing/sketching surface over the high-tech device interface (Figure 2). This use of the clear panels on top of a high-tech prototype creates the mixed-fidelity design environment. The name of the technique, Clear Panels, refers to the mixed-fidelity technique described, whereas the clear panel (in lowercase) refers to the small acetate panels composing the low-tech material.

CLEAR PANELS TECHNIQUE IMPLEMENTED

Here we detail a case study example of using the *Clear Panels* technique over three 90-minute sessions, with a multi-generational design team comprised of seven child designers (aged 8-14) and seven adult researchers [3] to design a new mobile application to teach math. Each session was structured to include core design activities with groups of 2-3 children working with 2-3 adults, and pre/post-activity discussion time with the entire team.

Stage 1 - Idea Generation

To brainstorm initial ideas, Cooperative Inquiry design techniques were employed [2]. The multi-generational design team was divided into small groups, and each group was asked to create prototypes to teach number sentences, e.g., 2 + 3 = 5, to six and seven year-old students. Using everyday objects and art supplies, the teams created low-tech prototypes. The team brainstormed ideas that were of varying shapes, sizes, and functions and were not constrained to mobile device form factors.

At the conclusion of the design experience each group presented and described their prototype. One prototype example was a Number Sentence Computer Scroll that would enable children to place digits and operators in a number sentence to learn how to solve equations. Interestingly, the scroll was portable (like a mobile device) in that the children envisioned rolling it up to carry in a backpack for school.

Stage 2 – High-tech Prototype Implementation

The low-tech design ideas generated in the brainstorming session formed the basis for creating the high-tech prototypes used with *Clear Panels.* When describing their low-tech prototypes, the children used such phrases as

"*I choose this number and put it here*",

"*You can say 'Take the minus sign and put it over there'*",

"*If you change the six to a three*",

"*You can move the operators around",*

"This will explain to me"

The prototype was implemented as a mobile application on commercially available mobile devices using the Android Operating System. Though implemented on an actual mobile device, much of the interaction details were not included. This intentional incompleteness provided the design space to enable a more unrestricted, open-ended design experience. For example, though the children mentioned *taking* and *moving* numbers they did not specify whether they wanted to scroll, tap, pinch or use a different gesture based interaction. The incompleteness ensured that the children remained in the role of design partner rather than tester of applications in which design decisions were pre-determined by the adults.

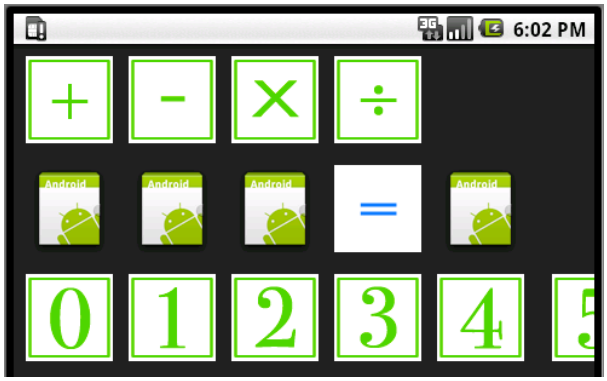

Figure 3 High-tech Computer Scroll Prototype

Stage 3 – Mixed-Fidelity Clear Panels

At the beginning of this stage the design team discussed the affordances and constraints of mobile device interactivity: screen size, lack of mouse and keyboard, portability and location awareness. The design partners also shared the ways in which they interact with mobile devices. To support designs using gestural interaction, we created a set of symbolic notations and introduced them to the team during this session. The discussions during this stage are important, because while many of the children have access to cell phones, they may not consider their experiences with other mobile devices such as Nintendo DS [5] to be related to mobile devices, as they associate mobile with phones that they may be too young to own. Likewise, adult researchers may be expert cell phone users but not use newer touch interface devices. Discussions about prior experiences helped ensure all design partners had a common understanding of the interactions possible with mobile devices.

To complete this stage of the *Clear Panels* technique, acetate pieces were cut to match the dimensions of the mobile device screen. To protect the actual devices, pieces not covered by the acetate, i.e. the surrounding plastic, were covered with clear tape. Small groups were created within the design team and they were provided with several clear panels. The clear panel was then taped to the device in a manner that allowed the panel to sit exactly on top of the device's screen. Each group was then provided with a permanent marker that they used to draw on the panel.

On each clear panel, the teams were asked to sketch one gesture/interaction or combination of the two per panel. For example, to find digits not currently on the screen, a designer might draw a scroll symbol, as shown in Figure 4.

If there was clear space on the panel, the meaning of the drawn interactions was annotated on the panel; if there was no space, the annotation was done on a separate piece of paper. This process allowed for each panel to represent one complete interaction. The design task for this session was to consider how to maximize a user's ability to build relatively complex number sentences, despite the small form of the device.

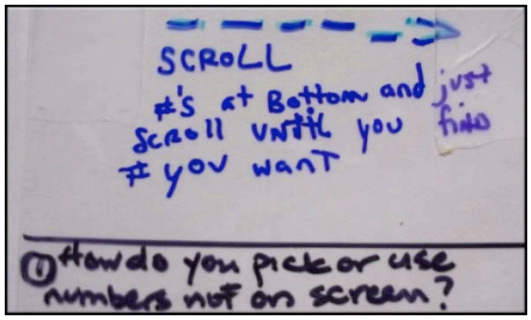

Figure 4 clear panel annotated with design ideas

DISCUSSION: SESSION ANALYSIS

The initial prototype was intended to be incomplete and had several known design challenges. Namely, there is not enough screen real estate to display each of the digits (0-9), as shown in Figure 3. Based on the children's low-tech prototype descriptions, we had implemented drag-and-drop interactions to move digits and operators in the number sentence; however, the small groups were free to refine or change the gesture-based interaction aspects of the application during their *Clear Panels* prototyping.

Analysis of the drawn panels revealed a common set of desired gestures, such as *scroll* and *flick,* to reach non-visible interface components. Overall, we also found that the design team preferred tap and press gestures to the initial drag-and-drop interactions. These findings were used to develop a second iteration of the prototype that included tap versus drag-and-drop gestures, and a scrollable number gallery (a modification of the widget commonly used to view groups of pictures).

The children used words such as *pick up, put, throw, go over, take, change, and move* to describe the interactions they wanted to use in their low-tech prototypes. However, the unconstrained nature of these prototypes left the interaction at a broad, non-platform-specific level. The use of *Clear Panels* as a follow-up technique allowed for interactions to be refined and constrained for mobile devices. The children's word-choice also evolved between the two sessions. When describing their mobile-sized panels to the group, the children used words such as *pinch*, *tap*, *flick*, and *scroll*. While we recognize that the introduction of a gesture vocabulary contributed to this, the children's descriptions reflected that the use of the mixed-fidelity prototyping contributed to a growing awareness of the constraints of mobile designs. For example, when one group drew an interface on an 8x11 sheet of paper, one child commented *"I think it would be too small to work on if you put it on that screen"* noting the difference in size between the sheet of paper and smaller mobile device.

One of the challenges with this technique was found to be the size of the writing space. Some of the children tended to write in large print and did not have enough annotation space on the panels themselves. In these instances additional paper was provided for annotation purposes.

CONCLUSIONS AND FUTURE WORK

As mobile technologies evolve and proliferate, so do the ways in which we interact with them. To respond to the changes in interaction modes, we believe that new design techniques are required. *Clear Panels* is a technique that aids in the design of gesture-based interactions. Our contribution lies in the use of actual mobile devices augmented with hand-drawn sketches. The use of mobile devices, rather than mock-ups, enable designers to accurately experience the size and weight of mobile devices in an authentic manner. The use of the low-fidelity sketching enables designers, regardless of age and technical ability, to design gesture-based interactions in a meaningful way. Our future work includes the use of *Clear Panels* to design gesture-based interactions for mobile devices in game-like contexts familiar to young children.

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