“PAPER IN SCREEN” PROTOTYPING

A RAPID TECHNIQUE TO ANTICIPATE THE MOBILE USER EXPERIENCE

Diego Fernando Pulido

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Master's Project Committee

_____
Davide Bolchini, Ph.D., Chair

_____
Anthony Faiola, Ph.D.

_____
Mark Pfaff, Ph.D.

Dedicated to my wonderful and supporting parents.

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ABSTRACT

Diego Fernando Pulido

"PAPER IN SCREEN" PROTOTYPING: A RAPID TECHNIQUE TO ANTICIPATE THE MOBILE USER EXPERIENCE.

Prototyping is generally acknowledged as an effective method for generating cost-effective, preliminary designs of various products including web and mobile user interfaces. Out of the existing types of prototyping, paper prototyping is known for being the most cost-effective of them all, as well as the most constrained for the realistic user experience elements it can render. High-Fidelity prototypes on the other hand offer a richer experience to the user, at the high cost of developing sophisticated software/hardware-based demonstrations. Although both of these types of prototypes continue to be widely and successfully used in product and interface design, there is no evidence of a cost-effective technique that would elicit user's feedback which as rich as high-fidelity prototypes but without implementation effort. This study proposes an innovative prototyping technique called "Paper in Screen" (Bolchini, Pulido, Faiola, 2009) which enables designers to cheaply and rapidly prototype a mobile application in its key components (interface design and mobile device integration) without the need for implementing a high-fidelity prototype. A study was performed with 10 user experience professionals to evaluate their perception of the technique's effectiveness, from which a number of benefits and drawbacks of the "Paper in Screen" were learned. The obtained results point to areas of future research in mobile prototyping.

1. INTRODUCTION & BACKGROUND

1.1 Introduction and Importance of Subject

The practice of prototyping has been relevant and valuable to society in general for a long time. Inventors such as Leonardo da Vinci are known to have made prototypes in the form of drawings. Another important inventor, Thomas Edison, is also known for his prototyping practices, which, unlike Da Vinci, also produced a number or physical prototypes. Edison's prototyping not only served the purpose of communicating an idea, but also communicated manufacturing requirements, needed parts and even possible costs (Arnowitz et. al., 2007). One of the most significant industrial designers of our time, Henry Dreyfuss used prototyping in a way that more closely resembles how it's currently used in software design. He also conveyed prototyping as a unique practice to communicate designs to stakeholders and better evaluate designs (Dreyfuss, 1967). These examples show the evident and considerable impact that prototyping has had in industrial design and engineering, for without it, mass production of products and consumer goods would not have evolved the same way they have up to date.

One of the most holistic definitions of prototyping is that proposed by Peter Coughlan, Jane Fulton Suri & Katherine Canales from IDEO: "[prototyping] involves moving from the world of abstract ideas, analysis, theories plans and specifications to the world of concrete, tangible and experiential things" (2007, p.3). Since prototyping allows for an idea to manifest in some material form, it serves as a perfect artifact to test such idea. Prototyping is also naturally of great importance in the world of engineering. Christiane Floyd (1984) highlights that "prototype," which literally means "first of type," is a notion

that makes sense in areas where a manufacturer's goal is to mass-produce goods of the same type and a model is produce in advance to show essential features of the final product. Hence, prototyping in engineering is also used to evaluate an idea and better inform further production of a particular item. This further enhances the importance of prototyping before the creation of software. Nevertheless, Floyd clarifies that in terms of software development, the interest lies "in a process, rather than in a 'prototype' as a product." (Floyd, 1984, p.2)

In terms of software development, such as web user interface design and mobile interface design, focus lies on "processes [that] involve an early practical demonstration of relevant parts of a desired software on a computer" (Floyd, 1984, p.2). In order to demonstrate any desired software part, prototyping techniques such as paper prototyping and high-fidelity prototyping exist to serve that purpose. Paper prototyping consist of a series of screens drawn on paper that resemble the design of the product being tested. Typically, designers generate a series of paper screens before testing the design with participants. The paper prototypes are then presented to the participants during testing, where they interact with the design and generate feedback that practitioners can use to inform their design. Paper prototyping is cost-effective since it requires nothing but one or various pieces of paper and the ability to clearly portray the design in question on them. Changes to one screen or "view" can be done rather quickly, even on the fly if the testing situation allows (See Figure 1.1). The feedback it generates is not constrained by participants' fear of criticism of the design; since it is evident the design being tested is not final and can be easily changed if needed.

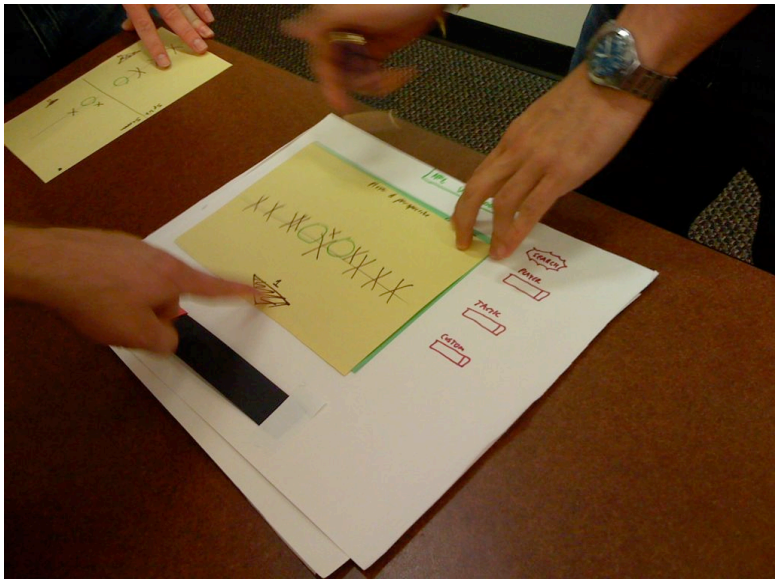

Figure 1.1. Paper Prototyping in Action

Despite all the benefits that paper prototype can bring to design testing, it has considerable drawbacks, particularly in terms of its inability to anticipate important elements of the user experience. The user depends on the person conducting the study to change the different screens, or "views" as the user navigates through the prototypes. Most importantly, paper prototypes make it difficult to anticipate the real-life context of a design. When a user is navigating through paper prototypes of a web site, the user is not sitting in front of a computer screen. Even more detached from a real user experience is testing with paper prototypes of a user interface for a mobile device: the user is not able to hold the mobile or handheld device in the hand. Not being able to see, manipulate and feel how the device would work in the appropriate context can hinder the user experience considerably. Even in cases where the mobile device is prototyped either with paper or

plastic, as in a previous study by Youn-Kyung Lim and Erik Stolterman (2008), the experience of using a real mobile device is far from the one enabled by such prototypes. They used different types of mobile device prototypes to test the level at which what they call the "manifestation dimension" (e.g. materials used to build the prototype) would affect the user's perception of the prototypes. After testing a paper prototype, they found that the user's inability to "push" the buttons in the keypad area and the confusion with the images' meaning due to their abstractness revealed that the resolution dimension matters significantly. Testing with a computer-screen based prototype yielded other type of user experience problems: users tried to click directly on the screen images instead of using the buttons on the keypad image; or tried to use the keyboard attached to the computer in order to type a text message. None of these problems were found when testing with an actual working mobile phone.

In order to account for the loss of context in user experience, designers can implement high-fidelity prototypes. These are prototypes that look close, if not exactly like the final product in terms of basic – simulated or implemented - functionality, navigation, content, color and layout. They can be interactive and can partially behave in the same way as the final intended product: for example, buttons can be wired to other screens to provide a sense of interactivity on a high-fidelity prototype of a web site or a mobile application without necessarily having to build any code to work on the back-end of it (see Figure 1.2.).

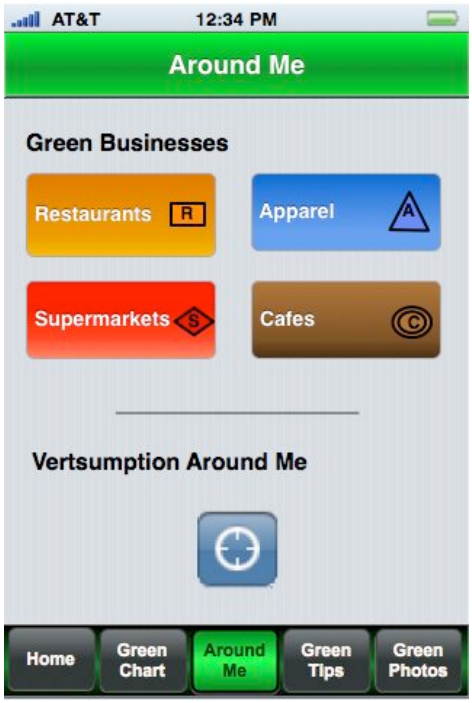

Figure 1.2. Example of an iPhone Application High-Fidelity Prototype

High-fidelity prototypes are extremely valuable in user testing due to their interactivity, but nevertheless have drawbacks in other aspects. The user might be inclined to not be as open to disclose any salient opinions on the user interface being tested since the prototypes appears to be close to or entirely finished (which is not commonly seen during paper prototyping testing). The user may not like certain interaction or visual design aspect of the prototype, but given that any considerable changes would not be as easy to implement as they would in lesser-fidelity prototypes, these usability and/or interaction concerns could go unaccounted for and ultimately into production. Most importantly for designers, although versatile, high fidelity prototypes can take a considerable amount of

effort and time in comparison to paper prototyping, especially when changes to the initial design need to be implemented. This area of research is valuable, particularly in terms of mobile user interface design. To date, there is no evidence of a technique that would allow designers to produce cost-effective prototypes to utilize in user testing (such as paper prototypes) whilst at the same time generating the richer type of user feedback that would result from users interacting with the high-fidelity prototypes in a mobile context. In other words, unless designers are able to build high-fidelity prototypes (hence, losing the flexibility to edit such prototypes if required), currently there is not a rapid, cost-effective way to anticipate in an *integrated fashion* two important elements of the mobile user experience: using a prototype mobile interface on a mobile device.

1.2 Problem Space / Target Users

This study has three main goals: (1) elaborating an innovative prototyping technique to rapidly anticipate the mobile user experience; (2) creating and exemplifying a toolkit that can be used by user experience professionals to use the technique; (3) empirically evaluating the effectiveness of this technique amongst a group of user experience design and usability professionals.

Specifically, this study has been created to test such a prototyping technique with the Apple iPhone. The iPhone is quickly becoming commonplace, with over 30 million units sold since its launch in 2007 (CNN Money/Fortune, 2009). With a device that only seems to gain market share by the day, it is clearly a relevant platform to design for and test with.

Since the proposed technique is a design prototyping alternative, the target users of this study are interface designers and usability professionals (also called " user experience architects/designers") who are familiar with various prototyping techniques, particularly paper prototyping. These target users will also be familiar with the look-and-feel (e.g. common UI elements, placement) as well as some of the basic interactions of the Apple iPhone (such as the swiping finger gesture of images).

1.3 Research Questions

Q1: What are the constitutive components of a prototyping technique that is able to anticipate the mobile user experience without the need of developing a high-fidelity prototype?

Q2: What feedback can be gathered from user experience professionals when presented with the "Paper in Screen" prototyping technique?

Q2.1: Do practitioners when performing a usability test acknowledge the "Paper in Screen" prototyping technique as effective and efficient?

Q2.2: Is "Paper in Screen" a technique that user experience professionals are willing to adopt and develop within their prototyping practices?

The answer to Q1 comes from the developed technique (Section 2.2) and the analysis from the participant's feedback (Section 5.1). The answers to Q2, Q2.1 and Q2.2 come from the analysis of the evaluative study with the participants (Section 5 and 6).

2. LITERATURE REVIEW

2.1 Theoretical Background and Related HCI Topics

User-Centered Design

Prototyping, in a great scale, has been utilized greatly in various engineering and design disciplines to generate testing concepts in the developments of various artifacts. Prototyping can be defined as the activity of making and utilizing prototypes - representative and manifested forms of design ideas- in design (Lim & Stolterman, 2008). Within the realm of Interaction Design and Human-Computer Interaction (HCI), prototyping has its roots in the interface design philosophy of User-Centered Design (UCD): an approach to design in which the wants, needs and limitations of the end user of an interface or artifact are given a particular attention on the design process. (www.upa.org, n.d.)

Usability and Contextual Design

The usability of any design, particularly in UCD, is of great importance in relation to prototyping. Usability, a central concept within HCI, can be defined as being about learnability, efficiency, memorability, errors and satisfaction (Nielsen, 1993). The Usability Professionals Association (UPA), as well as other researchers, has established similar activities deemed as necessary to create usable products: Observing and gathering information from end users; developing workflows, task analysis and user scenarios; a way to measure such observations, and iterative redesign as often as necessary (Gould & Lewis, 1985; www.upa.org, n.d.). In terms of getting to know the end user and gathering

the necessary information from them, Contextual Design (CD) is a user-center design process that provides designers with a methodology to successfully collect and interpret data from users. CD consists of a set number of steps: Contextual Inquiry, Work modeling, Consolidation, Work Redesign, User Environment Design, Prototyping and Implementation (Beyer & Holzblatt, 1998).

Usability could be designed into a product by default. Nevertheless, without testing the product, designers can never be sure if the design in question requires changes. UCD doesn't only aim towards good usability in designs. It also advocates for testing designs with end users and iterate on redesigns if needed. Usability testing gathers information from the end users by directly involving them into the design process. Another design approach involving users in the designing and testing of user interfaces is Participatory Design (PD). In PD, users are brought to the process in rather involved ways, sometimes designing the product in cooperation with the designers (Preece, Stern & Sharp, 2002). Other techniques used in PD to conduct usability tests involve live mockups, paper and simulation; low-tech objects with higher-tech video recording; and action role-playing (King, 1988; Muller & Kuhn, 1993; Jones & Marsden, 2006). Many of them are effective because they visualize requirements instead of simply describing them; they allow for safe experimentation as they involve some type of model that resembles the ultimate product. These artifacts are also commonly known as prototypes.

Prototyping in User Experience and Interaction Design

Prototyping is a crucial component within UCD. It is also central to the development of and motivation behind the "Paper in Screen" technique. In terms of product and software

design, prototyping is essential to create successful user experiences since it visualizes a clear depiction of software requirements (Arnowitz et. al., 2007). Another definition of prototyping that is deeply rooted in UCD and its iterative nature has been given by IDEO's product design consultant Bill Verplank, who says "prototyping is externalizing and making concrete a design idea for the purpose of evaluation" (as cited in Muñoz, 1992, p.577). It is clear that prototypes are crucial for representing and testing software ideas without having to finalize the product or the design in question.

It is important to understand there is not only one type of prototypes to be created or a single technique to craft them. Prototypes can involve different fidelities, look-and-feel or development processes. It all depends on the context every prototype is ultimately created in (e.g. a prototype created to communicate an idea to a design group may be different than a prototype build to be user in a usability test).

Anatomy of Prototypes

Much of the literature around prototypes seems to focus on the different purposes and processes in which prototypes are used, but not on their structure and organization. Youn-Kyung Lim and Erik Stolterman (2008) have proposed an anatomy of prototypes that help bring clarity to thinking about them and their nature. Their anatomy of prototypes include a "filtering" and a "manifestation" dimension, which corresponds to two different important characteristics, according to them: prototypes as filters and manifestation of design ideas. In terms of filtering, appearance, data, functionality, interactivity and spatial structures are dimensions that can be filtered in order to test core aspects of a design ideas in interactive systems. But filtering dimensions alone doesn't determine how to form a

prototype. According to Lim and Stolterman, what determines the specifics of how to form prototypes are issues of materials (e.g. what they are made of), fidelity (e.g. the prototype's resolution) and scope (e.g. how complete the prototype should be).

The anatomy of prototypes explains the importance of treating prototypes as a medium for exploring a design space by filtering certain aspects of design ideas, as well as a medium that externalizes those filtered aspects. Previous studies have demonstrated how different means of externalization affect considerably the way prototypes are perceived during usability tests (Lim, Pangam, Periyasami & Aneja, 2006). One of the issues spanning from the anatomy of prototype's manifestation dimension that most commonly drive the manner in which prototypes are formed are issues of fidelity.

Prototype Fidelities

Various kinds of prototypes, and their related prototyping techniques, can be classified in terms of their fidelity and the level of interactivity they allow (Mayhew, 1999). These can be more easily distinguishable between "low" and "high" fidelity. Low fidelity prototypes usually portray portions of the intended application; use paper, cardboard or other inexpensive materials; and are constructed without incurring very much effort or cost since they lack "built-in" interactive capabilities (Hakim, 2000). High fidelity prototypes on the other hand are typically built with appropriate software tools that allow for designs closer to the real product in mind, not only in terms of UI design (e.g. Adobe Photoshop, Fireworks, Flash) but also in terms of programming functional code (e.g. Visual Basic, HTML, ActionScript). They can sometimes be interactive enough to give users the impression of being a functioning product by allowing users to enter text, click

on active buttons and select icons to open windows (Rudd, Stern & Isensee, 1996). Both low and high fidelity prototypes can be used at different stages in the design process. They both have a set of advantages and disadvantages: low fidelity prototypes generally take less time to develop, cost less to produce and it maximizes the number of times designers get to refine a design before committing to code (Rudd, et. al., 1996; Rettig, 1994). Unfortunately they also have navigation and flow limitations, are primarily facilitator driven and have limited utility after the requirements have been established (Jones & Marsden, 2006; Rudd, et. al., 1996). Despite such limitations, low fidelity prototypes continue to be produced and tested in the design and redesign of various products and user interfaces.

Paper Prototyping

One of the easiest to produce and most common types of low fidelity prototyping involve simply using a piece of paper. Usability consultant Caroline Snyder (2003) describes paper prototyping as "a variation of usability testing where representative users perform realistic tasks by interacting with a paper version of the interface that is manipulated by a person 'playing computer' who doesn't explain how the interface is intended to work" (p.4). Paper prototyping, like most other low fidelity prototypes, doesn't require any technical skill, and allows you to collect information quickly, inexpensively and early in the development process before much effort has been invested in implementation (Rubin, 1994; Snyder, 2003).

High-Fidelity Prototyping

High fidelity prototypes can be interactive, partially functional user-driven, and can have

the look and feel of the final product (Jones & Marsden, 2006; Rudd et. al., 1996). Nevertheless, the fact that high fidelity prototypes look and feel so close to real products comes at a cost: they generally take longer to build, reviewers and testers tend to comment on "fit and finish" issues, can set expectations that would be difficult to change, and a single "bug" or technical problem could bring a test to a complete halt (Rettig, 1994).

Prototyping and Mobile User Experience Design

In mobile user experience and design, prototyping and other usability techniques are as prevalent as they are in the design of other products and services. Mediated data collection, simulations and enactments have been some of the emerging research methods on mobile technology testing and design (Hagen, 2005). Jeff Hawking, founder of Palm was responsible for one of the best examples in low fidelity prototyping in a mobile device. He used to carry a piece of wood in one of his pockets in order to simulate the experience of having what would ultimately become the Palm Pilot (Bergman & Haitani, 2000). Nevertheless, low fidelity prototypes don't seem to be as widely used in the design of mobile devices. Despite existing examples of previous successful attempts (Svanæs & Seland, 2004), there have been experiments that report certain low fidelity prototypes as misleading in regards to weight, size and interaction (Beyer & Hozblatt, 1988; Weiss, 2002).

Contrary to low fidelity prototypes, high fidelity prototypes have been used a great number of times in the mobile devices design process. Combining sensor-enhanced mobile phones with interactive spaces has allowed interaction designers to create and test

novel interaction with a mobile device (Ballagas, Memon, Reiners & Borchers, 2006). HTML pages have been loaded into a mobile phone and connected to a computer inside a backpack via Bluetooth to give the sensation of using a mobile application in the appropriate context and environment (Krauss & Krannich, 2006). Like these, many other examples show how high fidelity prototypes have been used to test products.

Visceral, Behavioral and Reflective Levels of Design

In terms of user experience, it is easy to see how high fidelity prototypes can account for an experience that is closer to a real product more compellingly than low fidelity prototypes. Even at a prototype level, some high fidelity prototypes account for what Donald Norman (2002) calls the "3 levels of design": Visceral, Behavioral and Reflective (Norman, 2002). The "visceral" level refers to the simplest, most primitive cognitive process. It relates to the look and feel of the product in question. The "behavioral" level refers to the device's embedded interactions and behaviors, as well as the behaviors of the users towards the device. Function is the centre of focus in this level and is what usability specialists tend to place the most focus. Finally, the "reflective" level refers to how a product appeals to one's aesthetic sensibilities and cultural preferences. These levels of design make it clear to see how high fidelity prototypes can render more accurate results in usability studies and information gathering than low fidelity prototypes. An exception to this claim can be seen with Jeff Hawkins' Palm Pilot low fidelity prototype. With a purposely-designed block of wood, Hawkins was able to feel the prototype's weight, feel to the touch, portability (Bergman & Haitani, 2000). These aspects are closer to the visceral and reflective levels of design that Norman refers to in

discussing the relationship of user experience and design.

Testing with Prototypes in a Mobile Context of Use

High Fidelity prototypes regain a very important aspect of the user experience with a mobile device that low fidelity prototypes don't have: context of use. The user interface of these high fidelity prototypes is inside the device, presenting it to the user in the ultimately intended device. Context of use is also accounted for outside of the device and more in regards to the users themselves. People testing such prototypes can grab the mobile device in their hands and interact with it closer to the way they would with a finished product. Nevertheless, it is evident that to be able to provide users with the right mobile user experience and context of use, prototypes require a considerable amount of effort, dedication and time to produce.

In search of evidence pointing to a way to test prototypes within the context of mobile devices, especially low-fidelity prototypes, a mixed-fidelity prototyping tool for mobile devices was found. Marco de Sá, Luís Carriço, Luís Duarte and Tiago Reis (2008) have devised an interesting and compelling software framework that allows the construction and testing of mixed-fidelity prototypes for mobile devices. By allowing for low, mid and high fidelity prototypes to be tested inside mobile devices, this framework appears to solve the lack of context that most low-fidelity prototypes seem to have. The framework goes beyond testing various prototype fidelities in the appropriate context. It also offers evaluation capabilities; integrated usability guidelines for mobile devices in mid-fidelity prototypes; and a log-player, which re-enacts via video all the users´ actions whilst interacting with a prototype; among other capabilities.

Despite all the benefits this framework brings to mobile interaction design and prototyping, particularly when testing with low-fidelity prototypes, this prototyping tool is in itself not easily replicable as it is based on complex software to function. Users would need to have this software framework already installed in a computer to be able to use it. Although this tool appears to be a seamless solution to testing low-fidelity prototypes in a mobile context, this is only from the point of view of testing participants. It doesn't easily offer practitioners and test facilitators a way to test low-fidelity prototypes in an appropriate context unless they have access to the software framework and the specific equipment to run it.

Within the literature researched related to UCD and mobile interaction design, and despite the availability of prototyping tools such as that proposed by de Sá et. al., it was not possible to find a practical and low-cost prototyping technique that would provide the appropriate mobile context during testing. Moreover, it was not possible to find a technique that would help anticipate the mobile user experience without the overhead and effort currently present in the creation and testing of high-fidelity prototypes.

2.2 "Paper in Screen" Prototyping

As indicated in section 2.1, all of the researched literature could not point to evidence of a way to prototype that would be rapid and economic to develop, yet could surpass the mobile user experience that paper prototype offers, without having to develop high fidelity prototypes. The "Paper in Screen" prototyping technique (Bolchini et. al., 2009) seems to be able to do this in a way no other established prototyping technique can.

"Paper in Screen" prototyping is a rapid and economical technique that aims at anticipating the mobile user experience by placing a paper prototype inside the mobile device. This technique uses paper prototypes that are created using traditional guidelines and best practices, but according to the authors of the technique, these prototypes can be easily digitalized "in a form that is suitable for integration and interaction with a mobile device" (Bolchini et al., 2009, p.32). By having users hold in their hands the actual mobile device that the prototypes intend on eventually being in, they can interact with them in a way that it captures a more realistic human-mobile interaction, only possible with more complex prototypes of higher fidelity than paper. Bolchini et al. (2009) also stated that "Paper in Screen" serves as a shortcut within the design life cycle between a reasonable amount of low-fidelity prototype iterations and more refined, electronic high-fidelity prototypes.

The "Paper in Screen" prototyping technique aims at providing a new way to interact with the low-fidelity prototype of a mobile application. For this reason, it's important to discuss a working definition of "interactivity" that fits this new technique.

Interactivity, put simply, implies both activity and interaction. Nevertheless, it is not an easy concept to define, as there is no universally accepted definition since researchers generally emphasize aspects of interactivity that fit with their work (Sundar, 2008). In an attempt to operationalize a perception-based approach to interactivity, McMillan & Hwang (2002) have discovered that there are three elements that constantly appear in interactivity research: direction of communication, user control and time. In regards to

"Paper in Screen" prototyping, these elements seem to be suitable reference subjects when addressing the interactivity level of the new prototyping technique.

Direction of communication is a factor that some researchers approach in terms of a two-way communication, as well as the capability of an artifact for providing feedback. Despite not offering a bidirectional level of communication, "Paper in Screen" prototyping seems to provide a level of feedback not present in paper prototypes. This is mainly because prototypes are simulated to be inside the mobile device and users get feedback from their input in a way that a paper prototype doesn't allow. This seems to go in accordance with Michael Naimark's (1990) definition of interactivity, which states that although information flowing in both directions is always required for interactivity, it is the user's input and its effects is what distinguishes it from non-interactivity.

Jonathan Steuer (1992) provides a definition of interactivity that shows an overlap between the concepts of user control and time. He defines interactivity as "the extent to such users can participate in modifying the form and content of a mediated environment in real time" (p.82). This definition involves real-time participation, which is relevant to "Paper in Screen" prototyping because there are no delays whilst progressively changing the "paper in screen" prototypes on the mobile device. This is important because with paper prototypes there is are more pronounced delays, which makes them less interactive when compared to "Paper in Screen" prototypes. Another definition of interactivity including the concepts of time and user control is given by Guohua Wu (1999). He defines perceived interactivity as "a two-component construct consisting of navigation and responsiveness" (p.6). This is relevant to the prototyping technique proposed by

Bolchini et. al. since "Paper in Screen" prototypes give users the *perception* that various prototyped states of an application are now rapidly changing inside the mobile device, even though the prototypes respond to the user's control in a very limited way.

Ultimately, "Paper in Screen" is hypothesized to be a very effective mixed-fidelity prototyping technique, for it involves various practical and valuable elements from low and high fidelity prototyping. It unleashes key factors of the user-prototype interaction currently unachievable with paper prototyping, such as heightened level of interactivity with the prototype in the intended device, as well as a more realistic and natural context of use. These factors have the potential to elicit different kinds of feedback and bring the advantage of a richer context during a usability test. They also address the targeted aspects of the mobile user experience that this new technique aims at incorporating. It must be stressed that these factors are only some of the many that compose "Mobile User Experience" as a whole, and that the aforementioned factors are the primary focus of the proposed prototyping technique.

Nevertheless, "Paper in Screen" does have some limitations. One of them is having less flexibility than paper prototyping in the sense that user interface screens cannot rapidly be changed if required. The technique makes it necessary for any given number of screens to follow a specific path or scenario and cannot adapt appropriately to any unexpected user interactions if needed. However, if the study involves one or more specific scenarios to follow, "Paper in Screen" is not at a disadvantage from paper prototyping. The technique also requires the mobile device being used to have the capabilities of displaying a photo or image in full screen (ideally without any other user

interface elements from the device visible) and the ability to navigate through images back and forth, via a button or by flicking/swiping with a finger (as with most touch screen mobile phones).

The cost of engaging in "Paper in Screen" is considered to be low, especially since the technique is based on the fact that it uses paper prototypes that would have already been made for regular paper prototype testing. Even creating new paper prototypes to be used with "Paper in Screen" is also a low-cost and short time effort. This is however, relative to the number of screens needed. Bolchini et al. (2009) stated that it takes about one hour of work for 7 or 8 screens to be converted to a "Paper in Screen" prototype.

Detailed next is a summary of the key steps in creating a fully working "Paper in Screen" prototype:

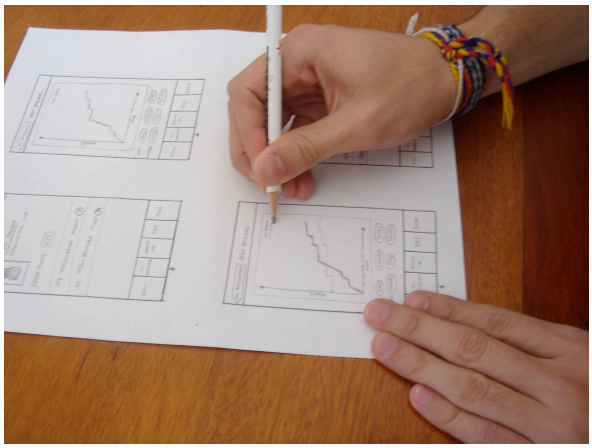

Figure 2.1. Design a Paper Prototype

1. Draw/Sketch

The process begins with designing a paper prototype. Practitioners can simply use a paper prototype that has already been made for testing. New paper prototypes can also be

converted to “Paper in Screen” prototypes. Assuming that the test involves the completion of a specific scenario, enough paper prototypes should be produced to represent the required amount of screens involved in it.

Figure 2.2. Digitalize Each Paper Prototype Screen

2. Digitalize

After the required number of paper prototypes has been sketched, the next step is to convert each prototype to a digital image, which can be done by taking a good quality photograph with a digital camera (authors of the technique recommend at least 5 megapixels).

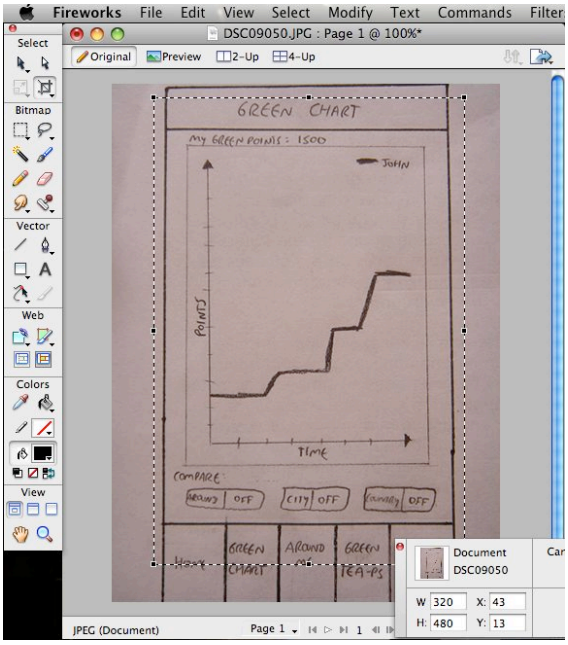

Figure 2.3. Optimize/Edit Each Digital Image

Alternatively, digital images of the paper prototypes can be gathered by using a scanner that allows for conversion of each image to an editable image file format (such as PNG, JPG or GIF).

3. Optimize

Once all the required paper prototypes have been digitalized, the next step is to edit each image in order to make them fit appropriately in the screen real estate of the mobile device to be used during testing with "Paper in Screen" prototypes. Using any photo editing software available such as Adobe Photoshop or Adobe Fireworks will work. In the example provided by Bolchini et. al. (2009) each image was resized to 320x480 pixels to fit the screen size of an Apple iPhone. If the optimization of each digitalized paper prototype is done properly, the border of each "mobile screen" should ultimately

match (or be close to matching) the one of the intended device and disappear from view once each image is synced with the mobile device.

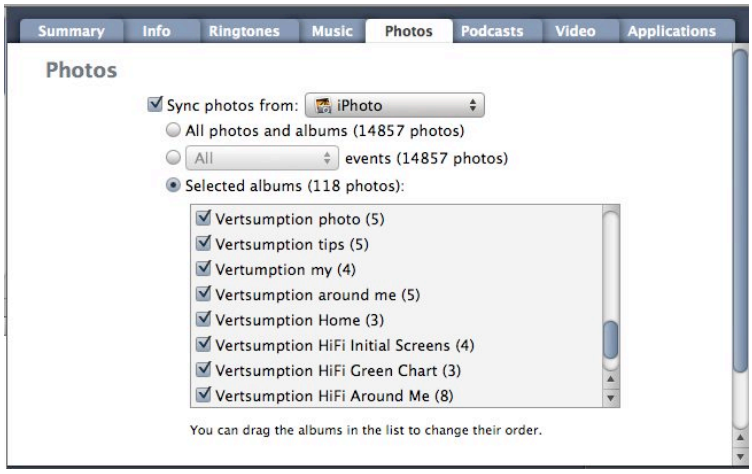

Figure 2.4. Organize Images in Folders to Upload to Mobile Device

4. Organize

After every digital image has been appropriately optimized to fit the entire screen of the mobile device as intended by the design, the next step is to organize the images in order according to the scenario they belong to. To do this, the images should be placed in order inside a folder so that it allows for sequential navigation of the images as intended. Then the folder (or "album", depending on the mobile device being used) should be named in a way that denotes it is a specific scenario. This way each scenario will be easily retrievable and opened during testing. In the examples provided by Bolchini et. al., (2009), created a number of different folders, each containing a number of optimized digital images of iPhone user interface screens. At this point, iTunes was used to manage and upload the required folders to an iPhone.

Figure 2.5. Upload Folders With Optimized Images to the Mobile Device

5. Upload

Once one or more folders have been chosen for testing, they should be uploaded using the computer's operative system, or any software meant to work with the mobile device of choice. As Figures 2.4 and 2.5 shows, iTunes was used to sync images between a computer and an iPhone. The iPhone displays each folder as a separate album in its native "Photos" application

Figure 2.6. Test the "Paper in Screen" Prototype with Participants

6. Experience

At this point, the "Paper in Screen" prototypes are ready to be used in a test with participants. Practitioners should explain how to properly navigate through the different screen images in every scenario, either by pressing a "forward" or "next" button to go forward, or flicking the photos with a finger sweep, the way many touch screen mobile devices allow. If possible to navigate images by flicking with a finger as on an iPhone, participants can be directed to flick each image by placing the finger in the general area where they would have "tapped" had this been a functional prototype; this is in order to better capture implicit and explicit feedback from the user. Directing participants to do this also allows them to have a more vivid interaction with the "Paper in Screen" prototype.

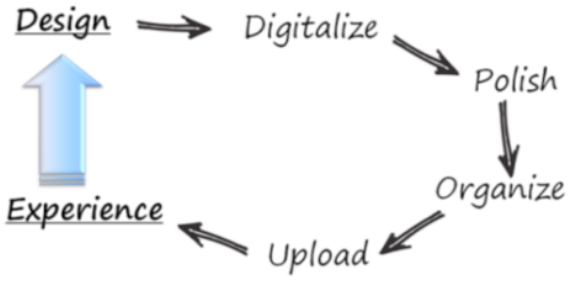

Figure 2.7. The “Paper in Screen” lifecycle

All of the previously mentioned steps show how the “Paper in Screen” prototyping technique allows for quick conversion of commonly used paper prototypes into a set of prototypes that can be experienced in the intended device itself. This is commonly seen only with more elaborate high-fidelity prototypes. It is also evident that “Paper in Screen” does not require complex machinery or very specific drawing or coding skills to produce a prototype that can be interacted with on a mobile phone. Some of the artifacts used in these examples, such a scanners, a digital camera and image editing software are consumer products easily available to most personal computer users and owners.

One of the hypothesized benefits of “Paper in Screen” prototyping lies in its similarity to paper prototyping in terms of where it is placed in the overall design cycle of an application. Paper prototyping allows practitioners to create prototypes easily and economically. It allows for quick disposal of those prototypes and easy re-creation as needed. This is important when testing designs and wanting to reiterate on variations of such designs based on feedback. Similarly, the “Paper in Screen” prototyping technique

allows practitioners to easily create and recreate prototypes for continuous and iterative testing, with the hypothesized advantage that instead of providing users with a prototype on paper, the prototypes they experience would reside in the intended device where the application would ultimately be used, hence more closely anticipating the mobile user experience. This shows the “Paper in Screen” lifecycle (Figure 2.7.) is able to come full circle and fits the overall lifecycle of the design of an application in a similar way that paper prototyping allows.

3. EVALUATION METHODOLOGY

3.1 Participants

The total number of subjects in this study was 10. All 10 subjects underwent the testing session in the IT building at IUPUI. Since this was a test targeting practitioners who were familiar with iPhones and most importantly who were knowledgeable in the practice of paper prototyping user interfaces, participants needed to originate from academic and/or professional areas such as Human-Computer Interaction, User Experience Design, Interaction Design or other similar fields. Data regarding these participants' experience in these areas, most particularly prototyping can be seen on Table 3.1.

Experience in Usability/Design	**Users**	
	N	**%**
(Number of Years)		
0	1	10
1-2	2	20
3-5	3	30
6-10	3	30
11 or More	1	10
Times prototypes were created by participants in the last year		
0	1	10
1-2	2	20
3-5	1	10
6-10	2	20
11 or more	4	40
No opinion	0	0

Table 3.1. Participants' Previous Experience in Design

No individual was excluded from participation on the basis of gender, race, color, national origin, religion, creed, disability, veteran's status, sexual orientation, or age. The only people that would have been excluded from this study are people unfamiliar with prototyping, specifically paper prototyping since the study introduced a new prototyping technique that is strongly based on paper prototyping. Due to the nature of the study, which involves creating paper prototypes before the "Paper in Screen" technique is introduced; those who were unfamiliar with prototyping user interfaces were not invited to participate.

3.2 Treatment and Procedures

The conversations between the facilitator and each participant throughout the duration of each session were recorded in audio using Audacity software in an Apple MacBook Pro portable computer. This was done primarily to replace note taking. With an audio recording of each session, it was easier to gather all the answers from the participants, as well as any other reaction or insight that may have come from them during the study. Each participant individually experimented the use of the "Paper in Screen" prototyping technique by designing the user interface of a simple note-taking mobile application for the Apple iPhone, as guided and instructed by a facilitator. Before they began, they were asked some questions about their experience with paper prototypes, prototyping in general and usability studies.

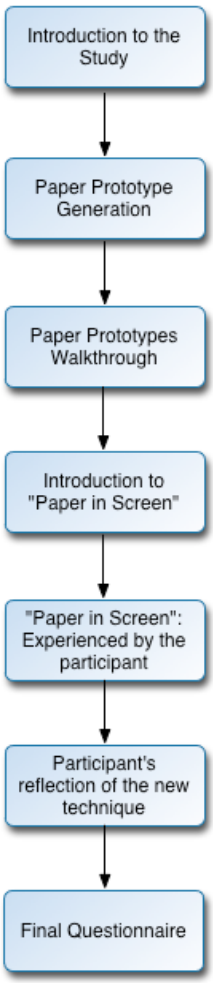

Figure 3.1. Overview of the Study Procedure

Paper Prototyping Generation

With the help of a facilitator, each participant was directed to generate a traditional paper prototype. Every participant was instructed to draw on paper the user interface of the application for 2 simple use case scenarios. To do this, each participant was provided with letter-sized individual pieces of paper with a drawing of an Apple iPhone without

anything on the screen. Each sheet of paper included a discrete yet visible grid (Figure 3.2) to help participants keep their drawings organized and as proportional as possible. With these sheets of paper, participants were asked to draw within the "body" of the iPhone; one separate page for each step in each scenario.

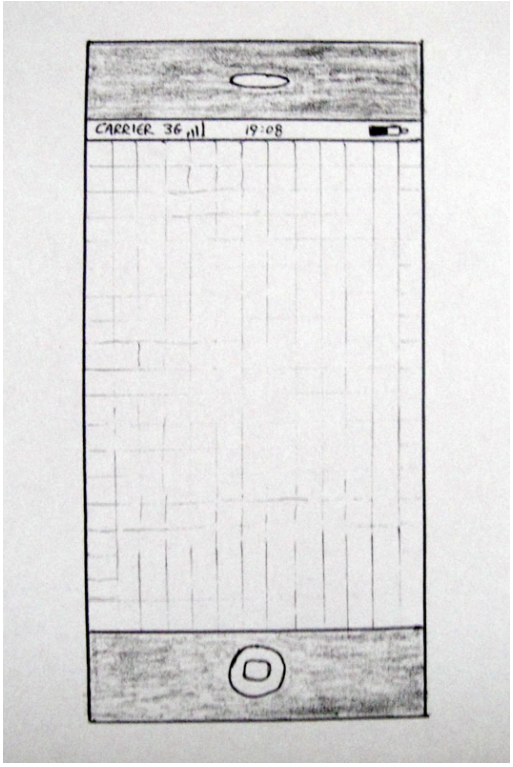

Figure 3.2. iPhone application template for paper prototyping

The application upon which the designs were based is a very simple note-taking application called "iNota". This is a fake application that was conceptualized for the sole purpose of using it in this study. The functions of this application included: taking audio or text notes, and saving either kind of note to the iPhone or to the user's iNota online account.

For the first set of paper prototypes, each participant was asked to design between 3 and 6 different paper prototypes for the following scenario: "*User takes a text note and saves it to the online account*". For the second set of prototypes, each participant was asked to design between 3 and 6 different paper prototypes for the following scenario: "*User takes an audio note and saves it to the iPhone*". The number of screens to be made for each scenario needed to be enough to convey the entire process depicted by the scenario.

Walkthrough With Paper Prototypes

Once they were finished prototyping the two scenarios, they were asked to walk the facilitator through the scenarios as if the facilitator were a test user for a usability study conducted by the participant. After this was done for each scenario, participants were asked a series of questions regarding their level of comfort using their paper prototypes, as well as other general questions about low and high fidelity prototyping.

"Paper in Screen" Introduction

After allowing the participant to review the paper prototypes, the "Paper in Screen" technique was introduced and explained. The participant saw how the facilitator makes use of the technique by taking the generated paper prototype format and digitalize it for the integration in the mobile device, and to incorporate it into an iPhone's screen dimensions. This was done by scanning each single piece of paper and saving each page as an individual image file, exporting it to Adobe Fireworks, cropping only the "iPhone screen" in each image file, saving each file accordingly into an "Audio" or a "Text" folder, exporting it to the iPhone by syncing those images via iTunes.

Experiencing "Paper in Screen" and Reflection

Immediately following these set of steps, each participant was handed the iPhone containing the paper prototypes they had just created and were directed to point where they would tap on the application, and swipe each image file to the left without releasing the finger after the new image appears. At this point, each participant was able to appreciate and review the "Paper in Screen" prototype generated, and use it as basis for guided discussion with the facilitator about perceived utility, efficiency and effectiveness of the technique and the process.

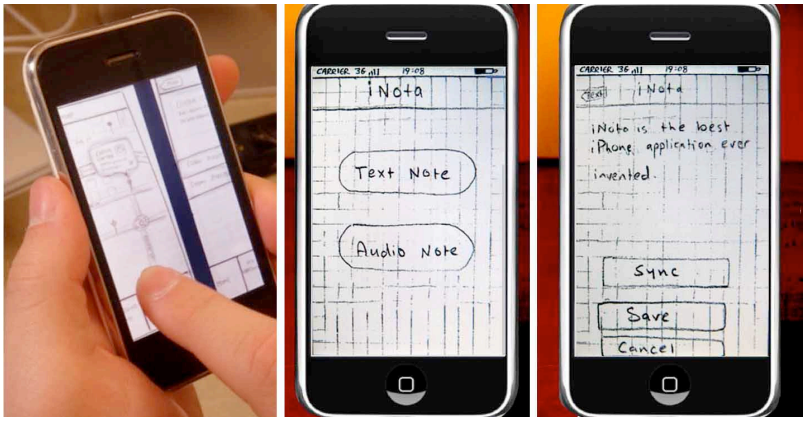

Figure 3.3. Interacting with "Paper in Screen"

Questionnaire

Finally, each participant was administrated a short questionnaire to gather more structured feedback on the newly introduced technique. This questionnaire was composed of questions geared towards investigating the participant's attitudes towards established prototyping practices, such as paper prototyping and high-fidelity prototyping, as well as towards "Paper in Screen" in comparison to the aforementioned prototyping techniques.

The questionnaire used a Likert-scale for the multiple-choice answer options in order to assess the participants' level of agreement and feelings towards the topics in question. Seven questions ranged from "strongly agree" to "strongly disagree". Another question's options ranged from "very important" to "not important". Finally, one question's options ranged from "very beneficial" to "not beneficial", as show in Figure 4.1 Figure 4.2 Figure 4.3. A table containing all the results from the final questionnaire can be found on Appendix D. After the participant is finished filling out the 3 pages of multiple choice questions in the questionnaire, they were given an Amazon.com gift certificate for $10 as a reward for having taken part in the study.

3.3 Data Analysis

The type of data that collected was gathered in the form of a transcript of the audio recordings; particularly of the answers to the questions asked during the study, as well as other salient remarks from the participants worth noting. The other type of data collected was the results of the questionnaire administered by the end of each session.

The principal method of analysis used in this study was entirely qualitative in nature. The goal was to identify recurring patterns or themes. The answers provided by the participants, along with any other salient comments were transcribed as individual sentences from the perspective of the participant and written in individual post-it® notes (see Figure 3.4). Once every important statement was transcribed on post-it® notes and coded with a number and letter that denotes the user responsible for each comment, they were analyzed via affinity diagrams.

Figure 3.4. Creating an Affinity Diagram

The affinity diagram, which is used in contextual design, aims to organize the individual notes captured into a hierarchy showing common structures and themes (Beyer & Holzblatt, 1998). These notes were grouped together into representatively labeled clusters during the interpretation session, if they were similar to each other in some manner. This type of grouping is not predefined and results out of the available data itself.

Following this exercise, the clusters of information gathered were consolidated into a more general model of work that is valid across individuals. This was done primarily to identify key roles across individuals (see Figure 3.5). Photos of these hierarchical diagrams were taken to aid the consolidation process. Finally, recommendations were made for improvement, based on theory derived from another approach to qualitative design called grounded theory (Glaser & Strauss, 1967).

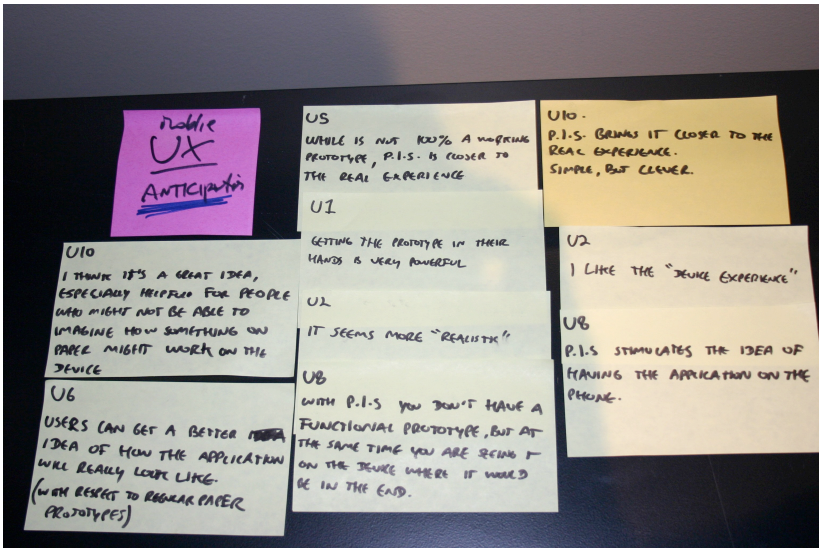

Figure 3.5. Clustering Participants' Comments by Common Themes

This method of analysis, which aims to develop theory from the systematic analysis and interpretation of empirical data, indentifies categories as basis for constructing a theory. Category identification was achieved by applying different types of coding to the data: open, axial and selective coding (Straus & Corbin, 1990). The goal for the use of these analysis approaches was measure the ability of the "Paper in Screen" prototyping technique to easily anticipate the mobile user experience, as well as the likelihood for user experience professionals to adopt it.

4. RESULTS

The main goal of this test was to empirically evaluate the perceived advantages and drawbacks of the “Paper in Screen” prototyping technique amongst a group of interface design and usability professionals, primarily by gathering their feedback. After an affinity diagram was created from the participant’s feedback during the testing sessions, the analysis of these results resulted in the following themes (see Appendix B for the full affinity diagram from this study):

4.1 Time-Effectiveness

Some of the participants found the “Paper in Screen” technique as a quick way to digitize a prototype that was easy to implement. In the event they wished to have a digitalized version of their paper prototypes, these participants saw great value in being able to have their paper prototypes converted into digital form in a rather short amount of time. For example one of the participants expressed the following statement: “I think “Paper in Screen” is taking a technique that is already very hard and digitizing it very rapidly too (P7-A9)”. Another participant said: “It’s pushing as close as possible to the digital realm without all the extra steps to get there (P7-A10)”.

Other participants found the “Paper in Screen” technique time-effective when trying to communicate their designs (in this case, iPhone application designs). One of the participants said: "With “Paper in Screen”, you can run the idea through someone quickly and better (P6-A7)”. Another participant also saw the “Paper in Screen” technique as

time-effective from a peer-to-peer perspective: “I find “Paper in Screen” fast and easy to discuss with your design team P6-A6”.

4.2 Suitable for Early Design Stages

Paper prototypes are rather convenient when quickly testing a design idea or concept. They are preferred during early stages of design, primarily because they are easy to create, recreate and dispose of –there is not an extraneous amount of effort loss when a paper prototype is thrown away. This is clearly not the case for digital prototypes (functional or not) where a lot more time and effort is spent in order to create them. With the “Paper in Screen” technique, some participants believed that it was adequate for early stages of a design, and overall a good way to gather and test design concepts and ideas. One of the participants said: “I think “Paper in Screen” is a bit more flexible than high-fidelity prototypes. It’s easier to revise (P6-B1)”. Another participant highlights the “sketchy” nature of paper prototypes and how this is present with “Paper in Screen”: “I like the sketchiness of “Paper in Screen”, which is important in early designs (P2-B4)”. The fact that a design looks “sketchy” and not as if a great deal of effort had been made in order to create it also allows users to feel more comfortable expressing their thought about the design and suggesting changes to it.

4.3 Anticipate the Mobile User Experience

Despite all the known benefits of paper prototyping, one of its most salient disadvantages is its lack of real-life context. Testing the prototype of the user interface of a mobile device is not the same when using a piece of paper as opposed to seeing it on a mobile

device itself. It was found that the "Paper in Screen" technique helps close that gap between low-fidelity prototypes and a more realistic user experience in a more appropriate context. One of the participants expressed their thoughts on this as follows: "I think "Paper in Screen" would be hands-on, which is good to gain back the context. A paper sits flat on the table (P7-C5)" Another participant said: "While it's not 100% a working prototype, "Paper in Screen" is closer to the real experience (P5-C11)". Benefits of the "Paper in Screen" technique were also seen from a purely practitioner's point of view, as this participant expressed: "The closer you can get to the context, the easier it is to see if as a practitioner, you've missed something (P3-C2)".

4.4 Engaging and Enjoyable

For the same reason paper prototypes fail to provide a closer user experience as it is intended, they may also fail to fully engage users when interacting with it. It is evident that when testing the paper prototype of a graphical user interface, it is still bound to the limits of a piece of paper. The "Paper in Screen" technique was regarded as more engaging and enjoyable for consequent users when testing prototypes than those made with paper. Such perception was perhaps due to placing such prototypes closer to the intended context of use and "involving more senses" as one of the participants expressed (P10-D6). Another participant said: "With paper prototypes you might get the same results as with "Paper in Screen", but the user might be more delighted to participate (P6-D4)". Perhaps this is due to the fact that it feels better to "actually touch things" as another participant explained (P10-D7).

4.5 Better Feedback Than With Paper Prototype

The goal of user testing is to gather feedback from those testing a design prototype. One of the most interesting results in this study was to find some participants believed that the "Paper in Screen" technique allowed participants to gather better feedback than with paper prototypes. This was primarily due to the fact some participants said that "Paper in Screen" helps visualize aspect that would be otherwise absent from paper prototypes, as this participant states: "I like that "Paper in Screen" puts the prototype on the device, especially if there are constraints that are device dependant like text-size (P2-E1)". Another participant mentioned how the "Paper in Screen" technique's proximity to a real life context is likely to enhance user feedback: "It would stimulate areas of their thought process that you normally wouldn't see because it gets you closer to context (P3-E7)". Even regarding iPhone-specific gestures, another participant expressed how having the prototype "inside the device" would prompt for using certain finger gestures otherwise users wouldn't think of using (P7-E2).

4.6 Practical for Practitioners

It was interesting to see not only how good was "Paper in Screen" for the end users, but also for practitioners themselves –especially since practitioners were the target users in this study. Some participants expressed how "Paper in Screen" would prevent them from being confined to a usability lab, or a closed-environment when doing testing a design. For example, one participant said: "You can't walk alongside someone with a stack of papers and simulate an experience, but you can with "Paper in Screen" (P2-F1)". Along

the same line, another participant said “Paper in Screen” would make it easier for me to carry [the prototypes] around. [it makes it] portable (P9-F5)”.

Given the inherently digital quality of “Paper in Screen” prototypes, other participants expressed how much they like the ability to “easily back up and reuse prototypes”, as this participant expressed: “You could use these images and post them on the Internet for others to test with their iPhones (P6-F6)”. Finally, in regards to scenario-based testing, another user said: “With “Paper in Screen” I could easily control the scenarios because I would not have to worry about sheets of paper getting out of order (P9-F8)”

4.7 More Difficulty in Gathering Feedback

Some users believed the “Paper in Screen” technique made it more difficult to gather user feedback in comparison to paper prototyping. This was primarily based on “Paper in Screen’s” need of extra-equipment to record any type of user feedback and the inability of end users to provide feedback on the prototype itself, as it is easily achievable with paper. One participant expressed his views on the “Paper in Screen” technique’s difficulty for gathering feedback as follows: “There is no way of recording feedback unless you use extra equipment [e.g. audio recorder] (P4-W3)” Another participant expressed the following after comparing how he is used to gathering user feedback with paper prototypes: “I would be worried about how to record side notes (meaning, ‘on’ the prototype) but that would be solved with audio notes (P4-W11)”.

Another participant mentioned one of the disadvantages in gathering user feedback with this new technique was a perceived learning curve in dealing with a “Paper in Screen”

prototype. One participant said: “Initially, I was having trouble swiping. I always wanted to ‘tap’ even when directed to swipe (P2-W7)”. Another participant mentioned: “With “Paper in Screen” users might be inclined to use multi-touch interactions, which could become a problem (P7-W9)” These statements relate particularly to the “Paper in Screen” technique as applied with an iPhone (swiping images forward), although it is evident that similar problems could arise when applying this technique in other mobile platforms.

4.8 Impractical and Rigid for Practitioners and End Users

One of the most salient concerns from the participants was regarding the linearity of the scenarios during a test, as this participant expressed: “due to the linear structure of “Paper in Screen” it would be hard to skip to the home screen if needed, which may take the user out of the ‘mindset’ a bit (P9-X4)”. Another concern was seen in regards to the inability for the practitioner to easily make changes “on the fly” to prototypes the same way it could be done with paper prototypes –hence making it a more “static prototype” as one user expressed (P4-X5). For example, another user said “A drawback might be that I can’t use a Post-It on a “Paper in Screen” prototype to quickly add a pop-up window or correct something (P9-X8).

4.9 Preference for a Functional High-Fidelity Prototype

Some participants didn’t see the much benefit with “Paper in Screen” in terms of digitizing a paper prototype in the way this new technique proposed. They seem to have preferred a more interactive and functional prototype if needing to use anything more elaborate than a paper prototype. For example one of these participants said, “With

functional prototypes, the user would know what the iPhone affords to do. That becomes a limitation of "Paper in Screen" (P7-Y3)". Even if using former paper prototypes was not seen as a problem, another participant mentioned how he would adopt the technique if such prototypes could simply be made more interactive (P2-Y2).

4.10 Recommendations

Whether participants liked or disliked "Paper in Screen", most of them expressed how they would like to see certain features added to the technique as a whole. Some users expressed how they would like to be able to convert paper prototypes into ""Paper in Screen" prototypes" more rapidly (P1-Z1, P1-Z2), as well as others expressed their desired for the technique to offer some sort of stencils (P6-Z6) or simply have an easier way to define the specific steps on how to apply the technique (P7-Z7).

4.11 General Positive Feedback

There were only 5 personal statements that were categorized as simple "general and positive feedback". For example, one of the participants said: "I think "Paper in Screen" gets ahead of the curve (P3-G2)". Another said "Taking paper prototypes and using "Paper in Screen" even with limited interactivity takes it to the next level (P2-G1)". These statements were positive, yet they didn't necessarily shed any valuable insights about the technique.

4.12 Results from Final Questionnaire

The final questionnaire rendered results that show a high level of acceptance of the "Paper in Screen" technique among the participants of this study. A great majority of participants agreed to the statements regarding the advantages and limitations of paper prototyping, as seen on the results for the first two questions in Figure 4.1. The following three statements regarding comparisons between "Paper in Screen" and paper prototyping in terms of worth of effort to produce, preference and dynamism of the experience resulted in answers falling in the "Strongly Agree" and "Somewhat Agree" categories only. The statement stating a preference to spend the required amount of time and effort

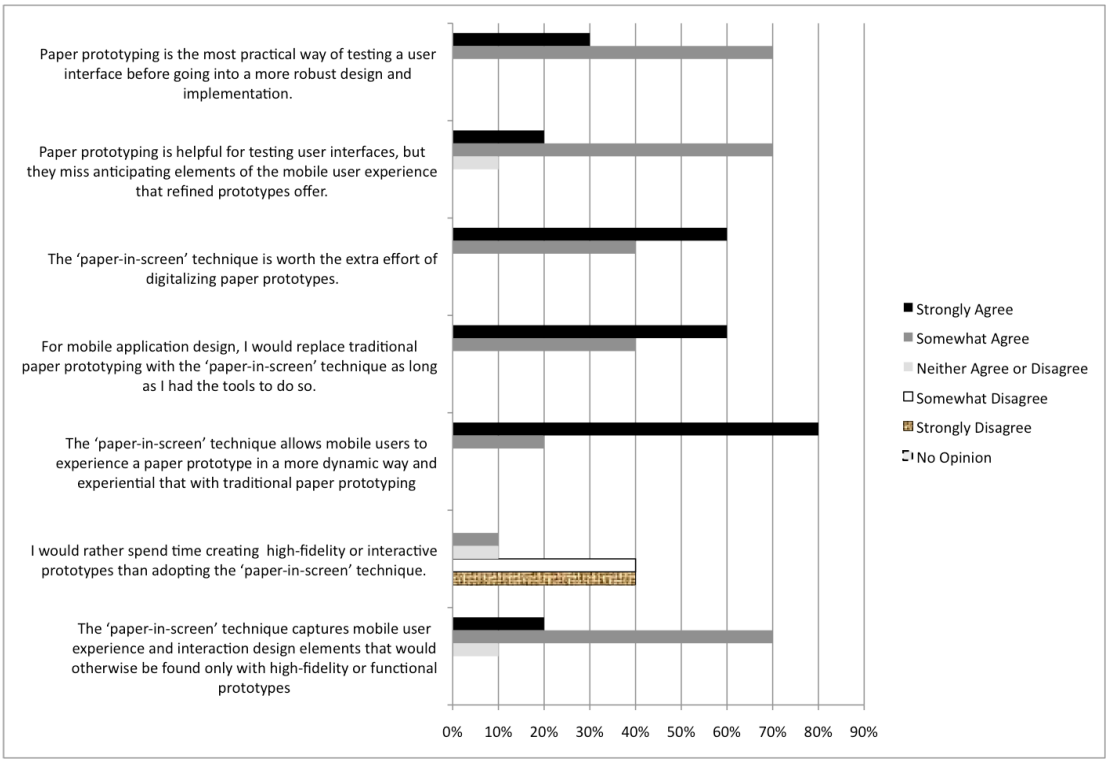

Figure 4.1. "Agreement" responses from Final Questionnaire (N=10)

to create high-fidelity prototypes instead of "Paper in Screen" prototypes was addressed with a considerable number of disagreeing answers. The reactions to this statement seem to go in accordance with some of the comments from various participants throughout the study who praised the capability of "Paper in Screen" prototyping to easily display various states of an application's user interface without the need to create high fidelity prototypes. The last statement in Figure 4.1, claiming that "Paper in Screen" captures the mobile user experience in a way only possible with high fidelity prototypes, was the least polarized of all the statements. Nevertheless, none of the participants disagreed with it.

The statements and related answers shown in Figure 4.2 and Figure 4.3 have been separated from the rest in Figure 4.1 due to a difference in answer options between the following two statements and the rest of in the final questionnaire. More on this issue is explained in section 6.2 of this study entitled "Limitations of this study". Figure 4.2 displays the high level of importance that most participants placed on the role of paper

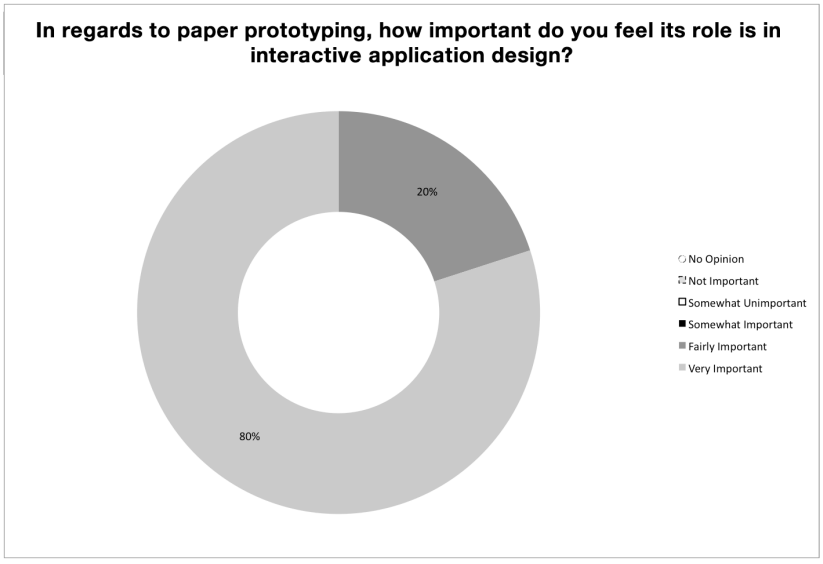

Figure 4.2. "Prototyping Role" Question's Answers (N=10)

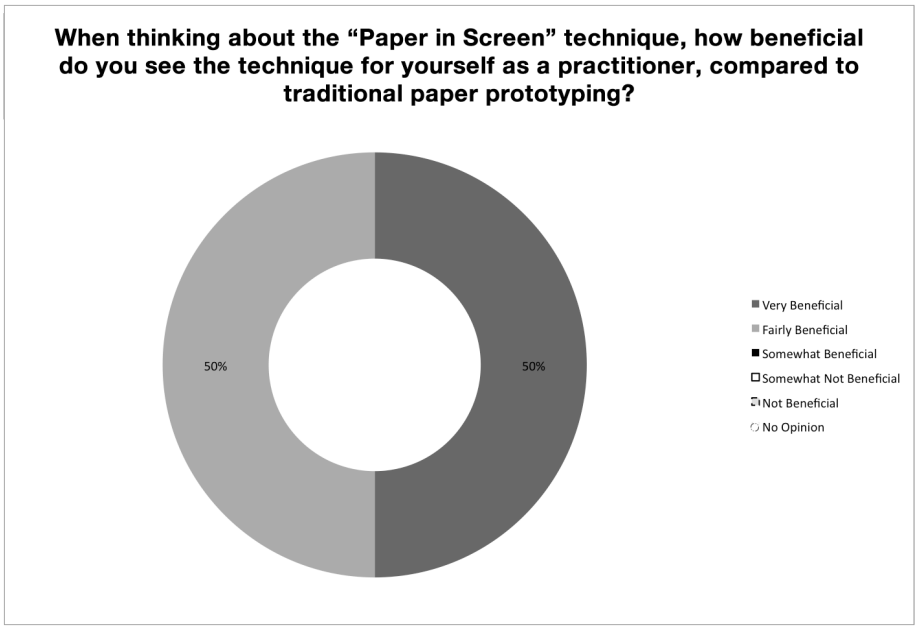

Figure 4.3. "Comparison" Question's Answers (N=10)

prototyping in the practice of interactive application design. Finally, Figure 4.3 shows that five out of ten participants saw "Paper in Screen" prototyping as a very beneficial in comparison to paper prototyping. The other five saw the new technique as fairly beneficial.

5. DISCUSSION

The results of the final questionnaire (completed by the participants at the end of the study) and the affinity diagram conducted after the study clearly demonstrate that the "Paper in Screen" technique is of great value to practitioners as well as end-users. They also indicate great potential for it to evolve into a more powerful prototyping tool. Nevertheless, these results also highlight a number of limitations and potential improvements that the technique should take into account.

"Paper in Screen" was developed with the goal of devising a prototyping technique that would allow for the anticipation of the mobile user experience without the need to create a high-fidelity prototype. Having this in mind, one of the main goals behind this study was to discover the components of such a technique by having practitioners in the area of user experience, interaction design and usability be exposed to the "Paper in Screen" prototyping technique.

5.1 Low-Cost Prototyping Technique Components that Anticipate the Mobile Experience

Based on the results from this study, the following components were found:

Contextual Interaction Experience

Interacting with a prototype that is easy to create in the context where the final product would be (e.g. an iPhone application on a real iPhone) was regarded as very important to anticipate the mobile user experience. Having the "device experience" (P2-C10) and utilizing this prototype "hands-on" was seen as appropriate to regain the context that otherwise would be lost with a low fidelity prototype such as one made on paper (P7-C5).

Another user also mentioned that "it would stimulate areas of [the user's] thought process that would not normally be seen" due to regaining the context absent in paper prototypes (P3-E7).

Realism

Another aspect that was deemed important was for the prototype to look realistic, as one participant specifically mentioned (P2-C9). This was clear; as one of the many important aspects of high-fidelity prototypes besides interactivity is that they look close to or exactly like the intended finished product. Another participant mentioned, "I like that "Paper in Screen" puts the prototype on the device, especially if there are constraints that are device-dependant like text size" (P2-E1). Being able to display text size appropriately inside the prototypes was an aspect that also contributed to making not only "Paper in Screen" prototypes more realistic, but also the original paper prototypes themselves. This was done by adding a faintly drawn grid inside every iPhone screen template to be used in the paper prototyping stage of the study. It was important to add this grid, for without any graphic guidance, participants would not have a notion of how big or small text, as well as other user interface elements, should be. Drawing various elements of inconsistent shapes (particularly text) could result in a "Paper in Screen" prototype that is perceived as less realistic, in turn taking away from being able to anticipate the mobile experience.

Behavioral Level of Design

One of the participant's comments (P3-E7) about stimulating areas of the user's thought process that would not normally be seen, is evidence on another main component behind

a technique that would help anticipate the mobile user experience at a low-fidelity stage better than paper prototypes. With "Paper in Screen", participants were able to go past the visceral level of design (as introduced by Donald Norman) that relates to the way a user related to the look-and-feel of the product in question. Instead, users were able to take part in a more significant mobile user experience through the behavioral level of design, which refers to the device's embedded interactions and behaviors, as well as the behaviors of the user's towards the device. One participant specifically mentioned, "[practitioners] might be able to anticipate to some extent some iPhone-specific gestures…" (P7-E2). Another participant mentioned, "The medium can be a problem. A paper prototype is still in paper and pretending is difficult. (P1-E5). Hence, it is evident that most participants acknowledged the interaction with "Paper in Screen" prototypes allow for evaluating contextually appropriate and more relevant behaviors with prototypes inside the ultimately intended device.

Interactivity

One of the aspects paper prototypes lack the most is interactivity. They generally require a facilitator to walk users though the flow of a scenario during testing. Moreover, paper prototypes can't render an interaction that is close to the one that would be ultimately intended, especially since on paper the user would be looking down at a detached piece of paper instead of holding a mobile device in the hand. Clearly, being able to interact with a prototype in a more realistic way than looking at a piece of paper and pretending it's a mobile application is important to anticipate the mobile user experience.

With “Paper in Screen”, some interactivity was regained from simply “fusing” paper and a real mobile device, despite not being able to replicate an experience where the user would tap on a specific area of the screen and the prototype would react accordingly. One participant mentioned, “It’s not the same interaction as with real buttons, but it still gets closer to context” (P3-C1). Keeping in mind that participants were directed to swipe each screen to navigate through the scenario, as they would any other photo on an iPhone, it was evident that some interactivity was lost with this mode of interaction, despite being able to regain the mobile context missing in regular paper prototypes

5.2 Prototype-Digitalizing Speed

It was interesting to find that many participants highlighted the quickness with which the “Paper in Screen” prototyping technique allowed prototypes to be digitalized. As previously mentioned, creating a high-fidelity prototype takes considerably more time and effort than creating a low-fidelity prototype. With “Paper in Screen”, digitalizing paper prototypes in a perceived fast manner was an advantage worth noting for some participants during the study. One user stated that the technique “is pushing as close as possible to the digital realm without all the extra steps to get there” (P7-A10). This is greatly due to the fact that in the case of this study, the iPhone already had many of the elements necessary to implement “Paper in Screen”, as another participant mentioned (P5-A4); that is, being able to have a full image displayed without any user interface being displayed (iPhone’s built in Photos application); the ability to swipe across images; and image organization by folders (scenarios).

Themes (Letters refer to each specific theme)	**Quotes from Participants** ("P" refers to "Participant", the number next to "P" refers to the participant's number. The letter that follows refers to a "theme", then number next to the "theme" letter refers to the number of the response according to that theme)
(A) PIS IS TIME EFFECTIVE FOR PRACTITIONERS	*The iPhone already provides many of the things you need to do PIS (P5-A4); It's pushing as close as possible to the digital realm without all the extra steps to get there (P7-A10)*
(B) PIS IS SUITABLE FOR EARLY DESIGN STAGES	*I like the "sketchiness" of PIS which is important in early designs (P2-B4); PIS allow for figuring out user requirements and some basic interaction models (P6-B8)*
(C) PIS IS ABLE TO ANTICIPATE THE MOBILE USER EXPERIENCE	*I think PIS would be hands-on, which is good to gain back the context. A paper sits flat on the table (P7-C5); I think it's a great idea, especially helpful for people who might not be able to imagine how something on paper might work on the device (P10-C15)*
(D) PIS IS AN ENGAGING AND ENJOYABLE TECHNIQUE FOR PARTICIPANTS	*With paper prototypes you might get the same results than with PIS, but the user might be more delighted to participate (P6-D4)*
(E) PIS IS BETTER FEEDBACK FROM PARTICIPANTS THAN WITH PAPER PROTOTYPES	*With PIS, you might be able to anticipate to some extent some iPhone-specific gestures, unlike with paper prototypes (P7-E2); The medium is a problem. A paper prototype is still in paper and pretending is difficult. PIS allows you to get feedback otherwise you wouldn't get (P1-E5)*
(F) PIS IS PRACTICAL FOR PRACTITIONERS	*With PIS I could easily control the scenarios because I would not have to worry about sheets of paper getting out of order (P9-F8)*
(W) PIS DOESN'T ALLOW EASY GATHERING OF FEEDBACK FROM PARTICIPANTS	*There may be a bit of a learning curve. People would have to learn how to "swipe" as means of interacting with PIS (P8-W10); I would be worried about how to record side notes (meaning ON the prototype), but that would be solved with audio notes. (P4-W11)*
(X) PIS IS IMPRACTICAL & RIGID FOR USERS AND PRACTITIONERS	*Due to the linear structure of PIS it would be hard to skip to the home screen if needed, which may take the user out of the "mindset" a bit (P9-X4)*
(Y) A FUNCTIONAL HIGH-FIDELITY WAS PREFERRED OVER P.I.S.	*PIS would still require a facilitator, like with paper prototyping. A hi-fi functional prototype would not need that (P9-Y5); A functional Hi-Fi prototype still gets you closer to the real thing than with PIS (P8-Y4)*
(G) GENERAL POSITIVE FEEDBACK	*Taking paper prototypes and using PIS even with limited interactivity takes it to the next level (P2-G1); I think it's practical if used in the right context. (P7-G5)*
(Z) RECOMMENDATIONS: "I WOULD LIKE TO SEE..."	*I would adopt the technique especially if it offered some sort of stencils (P6-Z6).*

Table 5.1. Higher Level Themes and Participant's Quotes

The entire set of comments from the participants during the study, as well as their coding, can be seen on Appendix B (Affinity Diagram) and Appendix C (Affinity Diagram Data).

5.3 The Concept of "Feedback"

One of the most salient discoveries made after gathering the results of this study was the way in which different perspectives of the concept of "feedback" were affected by the "Paper in Screen" technique. Some participants expressed that "Paper in Screen" allowed for recreation of a contextually rich and significant mobile user experience, resulting in *better* feedback from users interacting with a low-fidelity prototype in a way they only would with a functional high-fidelity prototype. Despite such mentions, some participants also expressed that such better feedback was in fact *more difficult* to gather and account for during testing of a prototype. (See sections 4.5 and 4.7 above).

The main points of reference throughout the entire study, and for "Paper in Screen" as a whole, are paper prototypes (as a low-fidelity kind of prototype) and high-fidelity prototypes (such as partially or fully functional prototypes). The perception of "Paper in Screen" rendering better feedback is based primarily in comparison to paper prototyping. Some of the most important comments from participants in regards to this are based on better prototype visualization, better (and closer to real) context of use and a more realistic human-mobile interaction, especially in terms of ergonomics and certain finger gestures from users. Conversely, comments regarding how "Paper in Screen" makes it more difficult to gather feedback drew from comparisons of testing with both low (paper) and high fidelity prototyping. Compared to paper prototyping, there was mention of the

technique's inability to allow test subjects (as well as practitioners conducting a test) to write notes on the prototypes themselves for future analysis; modify or correct prototypes on the go. To this point, it was also mentioned that "Paper in Screen" was at a disadvantage in the way in which feedback had to be recorded, specifically how extra-equipment was required for recording such as audio or video recorders. Although it is evident that having extra equipment able to record user's interactions with a prototype would be beneficial, depending solely on them could be a burden when trying to review feedback after the study has take place.

5.4 Implications of the Results

All of the aforementioned analysis has ultimately yielded a way of placing the "Paper in Screen" prototyping technique in relative position to paper and high-fidelity prototyping. "Paper in Screen" provides practitioners with a prototype that remains quick to produce and suitable for early stages of design, which are similar positive traits of paper prototyping. These traits are similar, yet not exactly the same, since, although "Paper in Screen" is cheap and easy to reproduce and replace repeated times, it is still not as flexible, malleable or agile to interact with as paper prototypes. "Paper in Screen" goes beyond paper prototyping in the sense that it allows practitioners to provide test-users with a prototype that is richer in terms of human-mobile interaction and is able to anticipate the mobile user experience more appropriately and effectively than paper prototypes.

Compared to high-fidelity prototypes, “Paper in Screen” allows practitioners quickly and easily providing test-users with prototypes that live inside a mobile device. This allows users to interact more realistically with a design prototype in a way that otherwise would have taken considerably more time and effort to achieve. On the other hand, what “Paper in Screen” seems to improve in design agility when compared to high fidelity prototypes, it loses in terms of actual mobile user experience, as it is not nearly as interactive, responsive or realistic-looking as a high-fidelity prototype (or even the final product) would be. Figure 5.1 shows this comparisons’ trade-off.

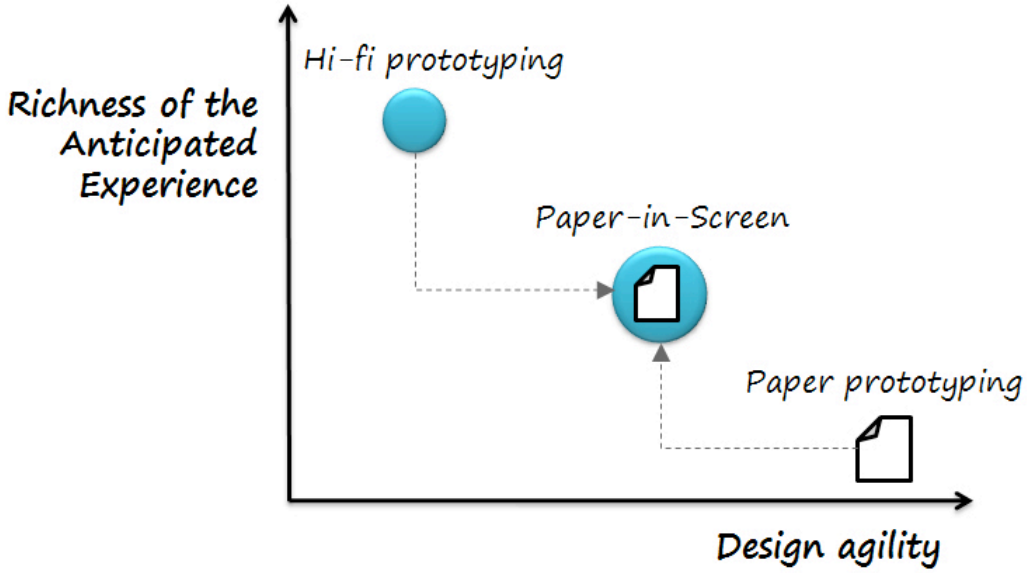

Figure 5.1. “Paper in Screen” in relation to other established prototyping techniques.

The overall experience of the participants of this study was overall positive towards the “Paper in Screen” technique. Although nearly every participant positively regarded paper prototyping as an important and practical way to test a mobile user interface, “Paper in

Screen" was also seen as practical, and ultimately effective in better capturing the end-user's mobile user experience.

Based on the final questionnaire administered at the end of the study, a vast majority of the answers were either "strongly agree" or "somewhat agree" (in a 5-point Likert scale) when referring to the benefits of both paper prototyping, as well as "Paper in Screen" prototyping. Only one participant chose the answer "neither agree or disagree" for a question stating, "*Paper prototyping was helpful, but missed on anticipating the mobile user experience as more refined prototypes did*". Only one participant for the following questionnaire statement gave the same answer: "*The 'Paper in Screen' technique captures mobile user experience and interaction design elements that would otherwise be found only with high-fidelity or functional prototypes."*

Although a majority of the questions in the final questionnaire were positive statements that participants could agree or disagree on, only one question was negative: *"I would rather spend time creating high-fidelity or interactive prototypes than adopting the 'Paper in Screen' technique".* Out of the 10 participants, 40% strongly disagreed and 40% somewhat disagreed with this statement. Only 10% neither agreed nor disagreed and the remaining 10% somewhat agreed to this statement. This question was introduced as a way to counter-balance the number of positive statements present in the final questionnaire in regards to "Paper in Screen". It was predicted that if the majority of the similar "positive" statements were to follow a trend, these "negative" statements towards the "Paper in Screen" technique would be the exact opposite to that trend. Results show this was indeed the case. It was interesting to note that this question was the one with the

most scattered answers out of the rest (four out of the five different points in the Likert scale were chosen to express agreement or disagreement with this statement).

Another interesting finding from the final questionnaire was the way the last question: *"the 'Paper in Screen' technique captures mobile user experience and interaction design elements that would otherwise be found only with high-fidelity or functional prototypes",* was answered. This question was different from the rest in that it compares "Paper in Screen" to high-fidelity prototypes instead of paper prototypes. Although responses to this question were mostly positive, 70% of the participants somewhat agreed to this statement, with only 20% strongly agreeing and 10% neither agreeing not disagreeing. This distribution of answer types suggests that although results were mostly positive, the majority of them are placed in between the highest-level of agreement (strongly agree) and the middle point in the 5-point Likert scale (neither agree nor disagree). This seems to indicate that despite the benefits "Paper in Screen" may bring to prototyping testing, they still represent an existent perception gap of mobile user experiences between high-fidelity prototyping and the technique proposed in this study. Nevertheless, the high level of agreement to statements highlighting benefits of the "Paper in Screen" technique over paper prototyping, as well as similarities in mobile user experience to high-fidelity or functional prototypes, seem to position "Paper in Screen" as a great alternative to either low or high-fidelity prototyping techniques. These answers also seem to go in accordance to the way "Paper in Screen" is placed in between paper and high-fidelity prototyping, as seen on Figure 5.1.

Finally, it was particularly interesting to compare the results from the final questionnaire

to the results of the affinity diagram. All the questions in the final questionnaire aimed at validating some characteristics of paper prototyping, high-fidelity prototypes and some hypothesized characteristics of "Paper in Screen" prototyping. It can be seen from the final questionnaire results that most of the answers seem to corroborate many of the main themes generated by the affinity diagram. From the final questionnaire, answers to question #3 regarding the ability of paper prototypes to help during tests but failing to anticipate the mobile experience and question #4 regarding the effectiveness of "Paper in Screen" in comparison to paper prototyping go in accordance with one of the resulting themes from the affinity diagram: "Theme E: 'Paper in Screen' yields better feedback from participants than paper prototypes". Answers to question #5 about the extra-effort involved in utilizing "Paper in Screen" being worth the time seem to corroborate theme "A": "'Paper in Screen' is time effective for practitioners". Answers to question #7 regarding opinions on whether the "Paper in Screen" technique allows mobile users to experience a paper prototype in a more dynamic way than paper prototypes seem to go in accordance with theme "D": "'Paper in Screen' is an engaging and enjoyable technique for participants". Lastly, answers to question #9 regarding opinions on whether the "Paper in Screen" technique captures the mobile user experience like otherwise found only in high-fidelity prototypes seem to go in accordance with theme "C": "'Paper in Screen' is able to anticipate the mobile user experience".

6. CONCLUSION

The creation of prototypes is an integral part in the design life cycle of computer, web-based, and mobile applications, among others. Anywhere from quick and easily made paper prototypes to functional high-fidelity prototypes, they all contribute to better informing a design throughout the development process. Despite having various benefits, as well as limitations, no compelling evidence was found of a technique that would help anticipate the mobile user experience in the same or a similar way that high-fidelity prototypes do but at an early design stage, without incurring in the effort and costs of producing a higher fidelity prototype, and in a time-efficient manner. This study has taken a step in the direction of defining a new prototyping technique called "Paper in Screen" that is able to anticipate the mobile experience by placing the paper prototype of a mobile application directly in a mobile device for test and user experience purposes. This study has also yielded interesting and useful results by testing this new prototyping technique with practitioners in the area of usability and user experience design in order to discover how effective and valuable it can be to people who conduct usability test and design prototypes at various fidelities. Moreover, these results have demonstrated the benefits of "Paper in Screen" for practitioners in anticipating the mobile user experience when testing with end users.

6.1 Limitations of the "Paper in Screen" Prototyping Technique

Testing "Paper in Screen" prototyping with user experience practitioners confirmed some of the hypothesized limitations of the technique. Some practitioners found the new

technique less flexible to manipulate when compared with paper prototyping, in terms of the malleability of the prototype once it was in the mobile device. This is a problem that could not be overcome in the way the technique was implemented for this study. Nevertheless, this could be easily solved if an application (for the iPhone, in this case) would be developed so that would allow to draw things on the image with a finger as well as the swiping of images *at the same time*. This could even ease the dependency on having to use external tools to record user feedback during a testing session, which is another limitation of the technique, according to some practitioners. Applications dedicated to drawing over images in the iPhone are readily available today.

Another evident limitation of the technique the level of interactivity that "Paper in Screen" prototypes currently allow. Even though this new prototyping technique allows for mobile application prototypes to be experienced in context that is closer to the one finally intended, the interaction with each screen could be greatly improved. Given the way the technique was implemented in this study, nothing more could be done besides simply swiping the images, regardless of whether the user performs this action near where a button or a link is on the screen. Such a limitation could be overcome if the capability to add "hot spots" to a specific area of a digital image in the iPhone is developed, similarly to the way Adobe Fireworks allows with any image file in a computer. If images could be given "hot spots" and linked to other images in an album, it could greatly enhance the interaction with a "Paper in Screen" prototype. Such a development would even solve another limitation that was evident during the study: the rigidness and linear nature of "Paper in Screen" prototypes during a test. With the

inclusion of “hot spots” on the digital images of paper prototypes, there would not be a need to structure different albums composed of images fitting a specific scenario. In turn, test users could be let to interact with the prototypes more independently and without the need for the facilitator to assist during a testing session.

It is important to highlight that the proposed strategies to deal with current limitations of the technique lie within the current state of software and mobile technology

6.2 Limitations of the Study

There were also a number of factors that may have limited the results of this study. One of them was that not all the practitioners that took part in this study were iPhone owners. Not only did this required the test facilitator to spend more time explaining the “Paper in Screen” technique more thoroughly, but it may have had an impact in the design of the paper prototypes that would later be converted to “Paper in Screen” prototypes, as they are not as familiar with what can be considered a “typical” iPhone application user interface.

Finally, as suitable as the iPhone was for the development and use of “Paper in Screen” prototyping, this new technique has not been tested in any other mobile device or platform. Heavily relying on the image viewing and navigation capabilities of the iPhone and it’s operating system could not allow practitioners to anticipate the mobile user experience whilst using this new technique as successfully as with an iPhone. For example, having to navigate through images by using physical buttons instead of tapping on a contextual menu button and swiping an image with a finger to change screen on the

device might hinder the mobile user experience as intended by the new technique. The inability of another mobile platform to make any user interface native to the mobile device disappear whilst navigating through images would have a similar consequence. Advancements in mobile technology, as well as an increased inclination towards the development of more touch-screen mobile devices (such as the Motorola Droid or the Nokia N900) could make this limitation less critical.

In regards to the testing session performed for this study, the way it might have been perceived by the participants in terms of the time needed to produce a "Paper in Screen" prototype could have been a limitation. Due to the fact that the study was structured to have participants begin by creating paper prototypes, immediately followed by "Paper in Screen" prototypes, there is a possibility that some participants might have perceived the process of creating a "Paper in Screen" prototype to be longer than it really is. In other words, there is a possibility that some participants may have not clearly understood that "Paper in Screen" could work based on paper prototypes that could have already been produced from a previous low-fidelity prototyping effort.

Finally, there is the possibility that an altered 6-point Likert scale in two of the questions in the final questionnaire may have impacted the results in way that would render their analysis less reliable. This is evident by looking at one of the charts, containing 7 out of the 9 questions (Figure 4.1) and the other separate charts for the remaining two questions in the final questionnaire (Figures 4.2 and 4.3). Out of the 9 questions, 7 were based on a 5-point Likert scale, which means that there are two "*strongly agree/disagree*" options, as well as two "*somewhat agree/disagree*" options, and a neutral option, presented as

"*neither agree nor disagree*". The remaining 2 questions represented by Figure 4.2 and Figure 4.3 were closer to a 6-point Likert scale, which offers the following options: "*Very Important*", "*Fairly important*", "*Somewhat important*", "*Somewhat unimportant*", "*Fairly unimportant*" and "*Not Important*". The main difference between the two versions of Likert scales is that a 6-point Likert scale does not offer a neutral option, as does the 5-point Likert scale. Unfortunately, the scale used in this study for these two questions omitted the "Fairly unimportant" option when presented to the participants during the time these questions were asked. Despite offering an incomplete 6-point Likert scale for these two questions, it was nonetheless interesting to find that this did not seem to affect the results for these two questions in relation to the other 7 questions asked in the final questionnaire. Answers to both questions fell under the "Very important/beneficial" and "Somewhat important/beneficial" options, which are comparable to the "Strongly agree" and "somewhat agree" respectively. For this reason, the data rendered from these two questions was accounted for in this study.

6.3 Future Research

"Paper in Screen" prototypes have proven to be a practical and useful way to help anticipate the mobile user experience with low-fidelity prototypes. Nevertheless, in order to further and more efficiently anticipate the mobile user experience, a way needs to be found to make "Paper in Screen" prototypes more interactive than the way they were presented in this study. A way to achieve this could be to build "Paper in Screen" prototypes in a way that supports navigating through scenarios in multiple possible paths,

as described in Section 6.1. This would differ from the interaction “Paper in Screen” prototypes provided to participants in this study in that it only offered the ability to navigate through a scenario in one fixed path.

Another useful direction could be to perform a more thorough study comparing the nature of the feedback from end-users between paper prototyping and “Paper in Screen” prototyping in order to discover more in-depth characteristics from both prototyping approaches.

6.4 Summary

This study highlights prototyping in low and high fidelities as a primordial part the design life cycle of any given application or product. Focusing specifically in the design of mobile applications, this study explores the various characteristics of low fidelity prototyping (such as paper prototyping) as well as high fidelity prototyping, and makes note of the absence of a prototyping technique that is able to help anticipate the mobile user experience at a lower cost than practitioners have to incur in with high fidelity prototyping. Given this, one of this study’s most salient contributions is a prototyping technique called “Paper in Screen” that aims at solving the absence of an agile technique to help anticipate the mobile user experience effectively.

Results of this study’s evaluation, which are qualitative in nature, support the assertion that practitioners found the “Paper in Screen” prototyping technique useful, efficient and effective in anticipating the mobile user experience compared primarily with paper prototyping. Furthermore, findings demonstrate that participants feel “Paper in Screen”

fits well at an earlier stage of design, like paper prototyping.

From a total of 10 user experience professionals who took part in this study, 60% strongly agree and the remaining 40% somewhat agree to the idea of replacing traditional paper prototyping with “Paper in Screen” prototyping if provided the tools to do so (Appendix D, Question 6). This seems to corroborate answers given by participants when asked if they would be willing to adopt the “Paper in Screen” prototyping technique in their practice, to which they all said they would do so.

Finally, analysis of this study’s results has yielded common themes based on participants’ perception of “Paper in Screen” via an affinity diagram. It also has produced a set of components present in a technique that helps anticipate the mobile user experience without the work involved in creating a high fidelity or functional prototype of a mobile application. These results show that a great majority of these are present in the newly developed “Paper in Screen” prototyping technique. Nevertheless there are important elements of such components that are crucial for “Paper in Screen” or any other easily reproducible prototyping technique to acquire when trying to help anticipate the mobile user experience. This study highlights this and other methodological limitations discovered during the study, and points out aspects that can be improved through future research.

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APPENDICES

Appendix A: Script for study with User Experience Practitioners

[the facilitator (Co-PI) will enact this script with each participant]

Thank you for participating in this study. You will learn a new technique that will allow you to perform paper prototyping in a more effective and compelling way.

We will begin by overviewing how the session will develop. The session is organized in two parts. In the first part, you will be asked to produce paper prototypes for a mobile application for the iPhone, following a simple set of instructions. In the second part, I will show you a new paper prototyping technique that extends traditional paper prototyping, and I will guide you through it so you can try to use it, test it and tell me what you think about it.

Q: Can you give me an example of a project you worked on where you incorporated paper prototyping into the process? What were the challenges that paper prototyping helped solve and what did you learn?

Good. Thank you.
Now, we can proceed with the first part of the session. I will ask you to produce a simple paper prototype for a mobile application for the iPhone around following 2 user scenarios. For each scenario you can expect to produce anywhere between 3 and 5 different screens. You will be provided with all the necessary information in written form for each scenario, as well as all the necessary user interface elements required in each scenario.
In order to produce the paper prototypes, you will be provided with enough papers containing empty boxes. These boxes resemble the size, shape and dimensions of the screen on an Apple iPhone. You can draw in them, and ask for new ones, should you need more as you produce the prototypes.

For this exercise, you will be designing paper prototypes of a hypothetical iPhone application that allows you to take text and audio notes wherever you are with your iPhone. This application is called *iNota*. This application saves your notes to the iPhone, and also syncs up with a hypothetical online account at www.inota.com, allowing you to keep the notes you want backed up online.

In case you are not familiar with the iPhone, here is, for example, the “NOTES” application of the iPhone, and here is what you can do with it [*the facilitator walks through the key features*].

Now, your paper prototype will include similar features, detailed in the instructions I will give you. Remember, for each scenario, you may produce anywhere between 3 and 5 screens that allow you, as a potential tester of these prototypes, to go through each scenario successfully.

Scenario 1: Enter a text note and synchronize it to your online account.

[*participant is presented these design requirements in writing, for detailed review and reference while drawing the interface screens on paper; the facilitator is available to help out the participant with further details or assistance*]

> User story: The iNota user begins at the first screen in the application (the main menu), which offers the choice of entering either a text note or record an audio note.
>
> The user chooses to enter a text note. Then, the user is presented a screen where the top half is the white area where the text will be displayed and the bottom part where the contextual keyboard appears.
>
> At this point the user types the following message: “iNota is the best iPhone application ever invented”.
>
> Then The user has the option of either saving the note to the phone, or syncing it over the air (via 3G network) to iNota.com.
>
> The user chooses to sync the note online. The user presses the “sync” button and in turn, sees visual feedback that the phone is currently processing that request.
>
> Finally, the user sees a visual feedback that the note has been successfully synced with iNota.com
>
> Remember to Include also the following User Interface elements:
>
> - “Text Note” button
> - “Audio Note” button
>   - “Back to Menu” button
>   - “Save” (to Phone) button
>   - “Sync”
>   - Contextual Keyboard

[*as the participant declares that the paper prototype is done*]

Now, you will be asked to do the same exercise for a second use case scenario. Remember, for each scenario, you may produce anywhere between 3 and 5 screens that allow you, as a potential tester of these prototypes, to go through each scenario successfully.

Scenario 2: Record an Audio Note and save it to the iPhone.

[*participant is presented these design requirements in writing, for detailed review and reference while drawing the interface screens on paper; the facilitator is available to help out the participant with further details or assistance*]

> User story: The iNota user begins at the first screen in the application (the main menu), which offers the choice of entering either a text note or record an audio note.
>
> The user chooses to record an audio note. Then the user is presented with a screen offering to "Record" an audio note. Once the user hits record and starts speaking to the iPhone, the "Record" button becomes a "Stop" button. The user speaks for 5 seconds and when the user is finished, the "Stop" button is tapped. At the bottom of the screen a line of text appears disclosing today's date and a timer displaying a 5 seconds recording, like this: "0:00:05".
>
> The user then saves the recording to the phone. The user does not sync it with iNota.com's account. When the saves the note, there is visual indication whilst the note is saving, as well as when the note is finished saving (so the user can tell is safe to do anything else with the phone)
>
> Remember to Include also the following User Interface elements:
>
> - "Text Note" button
> - "Audio Note" button
> - "Back to Menu" button
> - "Save" (to Phone) button
> - "Sync"
> - "Record" Button (turns into "Stop" button whilst recording

[*as the participant declares that the paper prototype is done*]

Great! Let's now briefly review your two paper prototype scenarios:

Q: How comfortable would you feel walking a potential user through these paper prototype scenarios?

Q: Please walk me through each scenario as if I were your testing user.

Q: What kind of assistance do you foresee giving the users of this paper prototype?

Q: What would you expect to find when walking a user this paper prototype?

Q: Compared to high-fidelity/electronic prototyping, what do you think is mainly beneficial about this paper prototype?

At this point, you will be introduced a to a new prototyping technique that utilizes the paper prototypes you have created to far and digitize them in a way that they can be imported and visualize into a mobile device, to anticipate a richer mobile user experience. The technique is called “Paper in Screen”.

First, I will show you an overview of the “Paper in Screen” technique and each of the steps involved in converting a paper prototypes into a appropriately-sized digital image. Then you will apply the technique to the paper prototypes you have created.

[facilitator illustrates, with support of pictures, the steps of the “Paper in Screen” technique]

Now I will guide you through apply the “Paper in Screen” technique in a number of steps. You will be told what to do in each step and I complete each step along with you.

1. Scan each paper prototype that you have created so far. Do so for all the screens in the 2 scenarios. Make sure that each screen is converted to an individual image file

2. Open each image file using Adobe Photoshop or Fireworks. Crop the area corresponding to that of the iPhone's screen real state

3.Resize the image to fit the following dimensions: 480 x 320 Pixels. This are the screen dimensions of an actual iPhone screen

4.Save every file to the desktop of the computer. Name each file in a way that helps you understand what screen is it, what order it follows in each scenario and which one of the two scenarios does it belong to. For example, the first image file for Scenario 1 could be named “S1-1”; the Second image file for Scenario 1 could be called “S1-2”; the first image file for Scenario 2 could be named “S2-1”…etc.

5. Create two folders in the computer desktop. Name each folder according to the two scenarios you have designed screens so far: "S1 text note and sync" and "S2 audio note and save"

6. Place each image file inside the corresponding scenario folder that it belongs to. For example, all the image files starting with "S1" will go in the "S1 text note and sync" folder and the image files starting with "S2", will go in the "S2 Audio note and Record" folder

7. With the iPhone (provided) connected to the computer, open iTunes and navigate to the iPhone sync area.

8. Click on the ¨Photos" tab and check the 2 scenario folders that you placed on the computer's desktop

9. Sync the photo with the iPhone

10. After the iPhone is finished syncing, unplug the iPhone and open the "photos" application. If synced correctly, you will see two folders, one for each of the two scenarios you have done paper prototypes for.

11. Tap on any of the two folders. Flick each photo back and forth inside the folder. Make sure that the images inside each folder follow the same order that you gave the screens when you designed them using traditional paper prototyping.

The facilitator will assist you if the folders do not have the appropriate images inside or if the are not in the desired order of the scenarios.

[once the participant has generated and used the "Paper in Screen" prototype]

Q: Was is your opinion on the difficulty level of the technique?

Q: Do the steps to apply the "Paper in Screen" technique seem practical to you?

At this point, you will go through each of the scenarios with a user (using the facilitator as a pretend user) the same way you would if you were using the physical paper prototypes. The difference in this case is that the user will be holding the iPhone and will wait for your commands as the scenario develops, from beginning to end. Allow the user to not only say what area of the user interface should be tapped, but also allow the user to touch the area and consequently swipe from one image to the other to navigate from one screen to another.

(after user has gone through at least the first scenario using the "Paper in Screen" technique, ask)

Q: What do you think of this technique so far?

Q: How do you compare this technique to traditional paper prototyping prototypes in terms of the information you can gather from the user?

Q: How do you compare this technique to hi-fidelity or electronic, clickable prototypes in terms of the information you can gather from the user?

Q: What is your opinion of the user handling the mobile device to navigate through the scenario as opposed to having in a piece of paper?

(after user has gone through both scenarios using the "Paper in Screen" technique, ask)

Q: What sort of additional benefits can you say this technique provides that can't be gathered via traditional paper prototyping in terms of the experience of the user? In terms of you as a practitioner giving the test?

Q: Would using the "Paper in Screen" technique loose any important aspect that could only be gathered through traditional paper prototyping?

Q: Would you be inclined to adopt this technique if you were to test the user interface of an iPhone application or any other mobile application?

Thank you very much for your participation. You will receive the digital photographs of the paper prototypes you have created in any format you desire, as well as the physical paper prototypes themselves.

Appendix B "Paper in Screen" Affinity Diagram

Appendix C: Affinity Diagram Data

[1]PIS IS TIME EFFECTIVE FOR PRACTITIONERS		
I THINK PIS IS FAST AND EASY TO IMPLEMENT	PIS HELPS COMMUNICATE DESIGN MORE EFFECTIVELY	PIS MAKES THE DIGITIZATION OF A PROTOTYPE QUICK
P2-A1 I don't think the technique is very difficult	P6-A6 I find PIS fast and easy to discuss with your design team	P7-A9 I think PIS is taking a technique that is already very hard and digitizing it very rapidly too
P3-A2 I don't think PIS is difficult at all	P6-A7 With PIS you can run the idea through someone quickly and better	P7-A10 It's pushing as close as possible to the digital realm without all the extra steps to get there
P4-A3 I think PIS is fast and affordable	P10-A8 As a practitioner, I would be able to explain better what I'm going to do, to give the users that extra sense of touch	P5-A11 I think PIS would work not only with mobiles but also web applications
P5-A4 The iPhone already provides many of the things you need to do PIS		P2-A12 The steps for this technique are not any worse than any other I could think of
P10-A5 I think PIS would save a lot of testing time with respect to paper prototype testing		P9-A13 I think PIS might be just as good, if not a little better than paper prototyping

PIS IS SUITABLE FOR EARLY DESIGN STAGES	
PIS SEEMS ADEQUATE FOR GATHERING DESIGN CONCEPTS AND IDEAS	I THINK PIS IS GOOD FOR EARLY DESIGN
P6-B1 I think PIS is a bit more flexible than Hi-Fi prototypes. Easier to revise	P2-B4 I like the "sketchiness" of PIS which is important in early designs
P7-B2 It may be a quick process, but if you are trying to test a great number of ideas, it may not be the same	P3-B5 Hi-Fi prototypes are one step away from the "finished" product. PIS is convenient for a design stage
P7-B3 If you are trying to test concepts to see which ones are best, PIS would be great	P6-B6 I think PIS is very good if you have participatory design in mind
	P6-B7I think PIS is good for early stages of design
	P6-B8

[1] PIS in this table refers to “Paper in Screen”

PIS allows for figuring out user requirements and some basic interaction models

P10-B9

I think functional hi-fi prototypes would only be helpful further down the line in the production cycle

PIS IS ABLE TO ANTICIPATE THE MOBILE USER EXPERIENCE

PIS SHOWS PAPER PROTOTYPES CLOSER TO THEIR INTENDED CONTEXT OF USE

P3-C1

It's not the same interaction as with real buttons, but it still gets closer to context

P3-C2

The closer you can get to the context, the easier it is to see if as a practitioner you have missed something

P4-C3

You are also likely to capture the environment where the product you are testing would be used.

P5-C4

PIS has found a way of dealing with the lack of context in paper prototypes

P7-C5

I think PIS would be hands-on, which is good to gain back the context. A paper sits flat on the table

P8-C6

With PIS, you don't have a functional prototype, but at the same time you are seeing it on the device where it would be in the end

P9-C7

I think you can understand at least the nature of the application and the context

PIS HELPS PROTOTYPES FEEL MORE REAL

P1-C8

Getting the prototype in their hands is very powerful

P2-C9

It seems more "realistic"

P2-C10

I like the "device experience"

P5-C11

While it's not 100% a working prototype, PIS is closer to the real experience.

P6-C12

Users can get a better idea of how the application will really look like. (with respect to regular paper prototypes)

P8-C13

PIS stimulates the idea of having the application on the iPhone

P10-C14

PIS brings it closer to the real experience. Simple, but clever.

P10-C15

I think it's a great idea, especially helpful for people who might not be able to imagine how something on paper might work on the device

PIS IS AN ENGAGING AND ENJOYABLE TECHNIQUE FOR PARTICIPANTS

P4-D1
With PIS you get rid of the awkwardness of having a piece of paper and pretending it's a computer screen. Users would be more comfortable using it

P4-D2
With PIS you are going to get more buy-in because users would be more comfortable giving feedback

P6-D3
I think PIS makes it more fun, the user would be more interested

P6-D4
With paper prototypes you might get the same results as with PIS, but the user might be more delighted to participate

P7-D5
I don't think it's too much of a leap for a user to understand what to do

P10-D6With PIS you get more senses involved

P10-D7
I think it's better than paper prototyping because you can actually touch things

PIS IS PRACTICAL FOR PRACTITIONERS

P9-F8
With PIS I could easily control the scenarios because I would not have to worry about sheets of paper getting out of order

PIS MAKES TESTING PORTABLE AND AVAILABLE OUTSIDE A ROOM

P2-F1
You can't walk alongside someone with a stack of papers and simulate the experience, but you can with PIS

P4-F2
PIS might work well with people who are not sitting at a desk

P4-F3
PIS would help me test in different environments, not just a room

P7-F4
It would allow me to test outside a room

P9-F5
PIS would make it easier for me to carry it around. Portable.

PIS ALLOWS FOR EASY BACKING UP AND REUSE OF THE SCNEARIOS' IMAGES

P6-F6
You could use these images and post them on the internet for others to test with their iPhones

P8-F7
I like that with PIS, images of prototypes are digital and you can always back them up online or on the PC

PIS YIELDS BETTER FEEDBACK FROM PARTICIPANTS THAN WITH PAPER PROTOTYPES	
I THINK PIS HELPS VISUALIZE ASPECTS THAT WOULD NOT BE POSSIBLE WITH PAPER PROTOYPES	YOU CAN GET BETTER FEEDBACK WITH PIS IN A WAY YOU COULDN'T WITH PAPER PROTOTYPES
P2-E1 I like that PIS puts the prototype on the device, especially if there are constraints that are device-dependant like text-size	P1-E4 You can get interesting feedback with hi-fi prototypes, but you can also get interesting feedback with paper prototypes if they are on the iPhone
	P1-E5 The medium is a problem. A paper prototype is still in paper and pretending is difficult. PIS allows you to get feedback that otherwise you wouldn't have gotten
P7-E2 You might be able to anticipate to some extent some iPhone-specific gestures. You would not be able to do this with paper prototypes	
P9-E3 It's hard to scale things with paper prototypes, so PIS gives you a better idea of what that scale might be	P3-E6 The user is likely to reference things that with paper prototypes they would not be likely to
	P3-E7 It would stimulate areas of their thought process that you normally would not see because it gets you closer to context
	P4-E8 PIS is an interesting interaction you wouldn't get with just paper prototypes
	P5-E9 I think users can give you better feedback than with regular prototypes
	P6-E10 I think it's intuitive. You can get more interaction from the user
	P6-E11 You can gather more emotions and feelings from the user than with paper prototypes

PIS DOESN'T ALLOW EASY GATHERING OF FEEDBACK FROM PARTICIPANTS		
EXTRA-EQUIPMENT IS REQUIRED TO RECORD ANY	IT TAKES SOME AWARENESS FOR PARTICIPANTS AT FIRST	THE TECHNIQUE DOES NOT ALLOW FOR FEEDBACK ON

USER FEEDBACK DURING TESTING	TO SWIPE INSTEAD OF TAPPING ON THE IMAGES	THE PROTOTYPE ITSELF
P1-W1 How would you record this? I would try to at least do audio, but it's prefer to record it on video P1-W2 I would adopt PIS if there is a way to record the sessions P4-W3 There is no way of recording feedback unless you use extra equipment (e.g. Audio) P7-W4 I think having a video recording of PIS would be ideal P7-W5 The practitioner would lose some visibility of the user's interactions with PIS and it might make it difficult to record for the practitioner P10-W6 A limitation may be that you absolutely need a scanner or some sort of image capturing device.	P2-W7 Initially I was having trouble swiping. I always wanted to "tap" even when directed to swipe P3-W8 The user might be confused with swiping at first, but I think it doesn't take long to get used to it P7-W9 With PIS users might be inclined to use multi-touch interactions, which could become a problem P8-W10 There may be a bit of a learning curve. People would have to learn how to "swipe" as means of interacting with PIS	P4-W11 I would be worried about how to record side notes (meaning ON the prototype), but that would be solved with audio notes. P4-W12 It would be difficult for the user to provide feedback in written form on the prototype

PIS IS IMPRACTICAL & RIGID FOR USERS AND PRACTITIONERS	
THE TECHNIQUE SEEMS LIMITED DUE TO THE LINEARITY OF HAVING TO FOLLOW A SPECIFIC PATH	THE TECHNIQUE DOES NOT ALLOW FOR QUICK, "ON THE FLY" CHANGES
P2-X1 What if the prototype branches out? It seems to be very scripted and that may be a limitation P8-X2 Unless scripted, it would be impossible to let the user act freely from just the home-screen P8-X3 I think having to follow a path/scenario is a limitation P9-X4 Due to the linear structure of PIS it would be hard to skip to the home	P4-X5 PIS makes a paper prototype a "static" prototype" P6-X6 With PIS, you couldn't make changes on the fly like you can with paper. You would have to run through the whole cycle again P9-X7 I would not have the random flexibility of using a sticky note in the middle of the study P9-X8 A drawback might be that I can't use a post-it on a PIS prototype to

screen if needed, which may take the user out of the "mindset" a bit

quickly add a pop-up window or correct something

A FUNCTIONAL HIGH-FIDELITY WAS PREFERRED OVER P.I.S.

P2-Y1
It's still not really a functional prototype

P2-Y2
I would adopt the technique if there was a way to make it more complex and interactive

P7-Y3
With functional prototypes, the user would know what the iPhone affords to do. That becomes a limitation of PIS

P8-Y4
A functional Hi-Fi prototype still gets you closer to the real thing than with PIS

P9-Y5
PIS would still require a facilitator, like with paper prototyping. A hi-fi functional prototype would not need that

GENERAL POSITIVE FEEDBACK

P2-G1
Taking paper prototypes and using PIS even with limited interactivity takes it to the next level

P3-G2
I think PIS gets "ahead of the curve"

P5-G3
I can't think of any limitations

P7-G4
I think PIS is something there is a need for.

P7-G5
I think it's practical if used in the right context

RECOMMENDATIONS: "I WOULD LIKE TO SEE..."

P1-Z1
I would adopt PIS if I can get the paper prototypes in the phone quickly.

P1-Z2
I wonder if the effort to make PIS is worth it. It depends... everybody is lazy. If it takes too long to produce a small reward it would be doubtful

P2-Z3
Having a grid on the iPhone template helps guide size of buttons and text

P3-Z4
Color would be nice, but if you were working with colored pencils, that would take care of that

P5-Z5
If there were tools that facilitated the interpretation of this technique I would adopt it.

P6-Z6
I would adopt the technique especially if it offered some sort of stencils

P7-Z7
If there was a way to define specific steps on how to do this, it would be helpful

Appendix D: Final Questionnaire and Results

Final Questionnaire

1. How many times have you produced paper prototypes in the last year?
   - None
   - 1-2
   - 3-5
   - 6-10
   - 11 or more
   - No opinion

2. In regards to paper prototyping, how important do you see its role is in interface design?
   - Very important
   - Fairly important
   - Somewhat important
   - Somewhat unimportant
   - Not important
   - No opinion

3. To what extent do you agree or disagree with this statement: "Paper prototyping is the most practical way of testing a user interface before going into a more robust design and implementation."
   - Strongly agree
   - Somewhat agree
   - Neither agree nor disagree
   - Somewhat disagree
   - Strongly disagree
   - No opinion

4. To what extent do you agree or disagree with this statement: "Paper prototyping is helpful for testing user interfaces, but they miss anticipating elements of the mobile user experience that refined prototypes offer "
    - Strongly agree
    - Somewhat agree
    - Neither agree nor disagree
    - Somewhat disagree
    - Strongly disagree
    - No opinion

5. When thinking about the “Paper in Screen” technique, how beneficial do you see it for yourself as practitioner, compared to traditional paper prototyping?
    - Very beneficial
    - Fairly beneficial
    - Somewhat beneficial
    - Somewhat not beneficial
    - Not beneficial
    - No opinion

6. To what extent do you agree or disagree with this statement: "the ‘papers-in-screen’ prototype is worth the extra effort of digitalizing paper prototypes”.
    - Strongly agree
    - Somewhat agree
    - Neither agree nor disagree
    - Somewhat disagree
    - Strongly disagree
    - No opinion

7. To what extent do you agree or disagree with this statement: "For mobile application design, I would rather walkthrough users with the “Paper in Screen” rather than with traditional paper prototypes (if I had the tools to do so)”.
    - Strongly agree
    - Somewhat agree
    - Neither agree nor disagree

- Somewhat disagree
- Strongly disagree
- No opinion

8. To what extent do you agree or disagree with this statement: "the ‘“Paper in Screen”’ technique allows mobile users to experience a paper prototype in a more dynamic and experiential way than with traditional paper prototypes"
    - Strongly agree
    - Somewhat agree
    - Neither agree nor disagree
    - Somewhat disagree
    - Strongly disagree
    - No opinion

9. To what extent do you agree or disagree with this statement: "I would rather spend time creating high-fidelity or interactive prototypes than adopting the ‘“Paper in Screen”’ technique"
    - Strongly agree
    - Somewhat agree
    - Neither agree nor disagree
    - Somewhat disagree
    - Strongly disagree
    - No opinion

10. To what extent do you agree or disagree with this statement: "The ‘“Paper in Screen”’ technique captures mobile user experience and interaction design elements that would otherwise be found only with high-fidelity or functional prototypes"
    - Strongly agree
    - Somewhat agree
    - Neither agree nor disagree
    - Somewhat disagree
    - Strongly disagree
    - No opinion

11. How many years of professional experience in the usability/design field do you have?

- None
- 1-2
- 3-5
- 6-10
- 11 or more

Results

Experience in Usability/Design	Users	
	N	%
1. In regards to paper prototyping, how important do you feel its role is in interactive application design?		
Very important	8	80
Fairly important	2	20
Somewhat important	0	0
Somewhat unimportant	0	0
Not important	0	0
No opinion	0	0
2. To what extent do you agree or disagree with this statement: "Paper prototyping is the most practical way of testing a user interface before going into a more robust design and implementation."		
Strongly agree	3	30
Somewhat agree	7	70
Neither agree nor disagree	0	0
Somewhat disagree	0	0
Strongly disagree	0	0
No opinion	0	0
3. To what extent do you agree or disagree with this statement: "Paper prototyping is helpful for		

testing user interfaces, but they miss anticipating elements of the mobile user experience that refined prototypes offer "

Strongly agree	2	20
Somewhat agree	7	70
Neither agree nor disagree	1	10
Somewhat disagree	0	0
Strongly disagree	0	0
No opinion	0	0

4. When thinking about the “Paper in Screen” technique, how effective do you see the technique for yourself as practitioners, compared to traditional paper prototyping?

Very beneficial	5	50
Fairly beneficial	5	50
Somewhat beneficial	0	0
Somewhat not beneficial	0	0
Not Beneficial	0	0
No opinion	0	0

5. To what extent do you agree or disagree with this statement: "the ‘“Paper in Screen”’ technique is worth the extra effort of digitalizing paper prototypes"

Strongly agree	6	60
Somewhat agree	4	40
Neither agree nor disagree	0	0
Somewhat disagree	0	0
Strongly disagree	0	0
No opinion	0	0

6. To what extent do you agree or disagree with this statement: "For mobile application design, I would replace traditional paper prototyping with the ‘“Paper in Screen”’ technique as long as I had the tools to do so"

Strongly agree	6	60
Somewhat agree	4	40
Neither agree nor disagree	0	0
Somewhat not beneficial	0	0

Not beneficial	0	0
No opinion	0	0

7. To what extent do you agree or disagree with this statement: "the '"Paper in Screen"' technique allows mobile users to experience a paper prototype in a more dynamic and experiential that with traditional paper prototyping"

Strongly agree	8	80
Somewhat agree	2	20
Neither agree nor disagree	0	0
Somewhat disagree	0	0
Strongly disagree	0	0
No opinion	0	0

8. To what extent do you agree or disagree with this statement: "I would rather spend time creating high-fidelity or interactive prototypes than adopting the '"Paper in Screen"' technique"

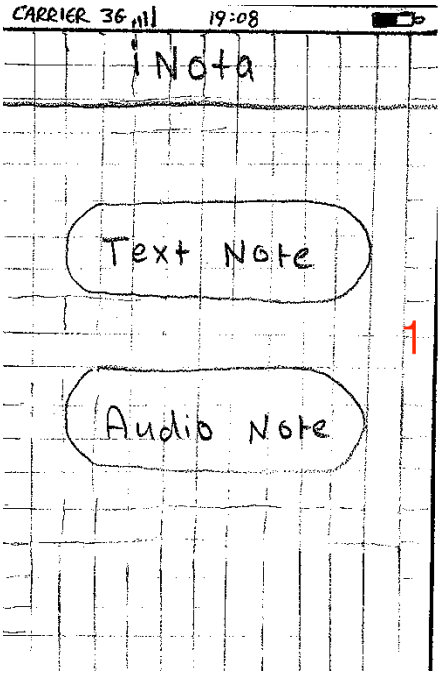
Strongly agree		
Somewhat agree	1	10
Neither agree nor disagree	1	10
Somewhat disagree	4	40
Strongly disagree	4	40
No opinion	0	0

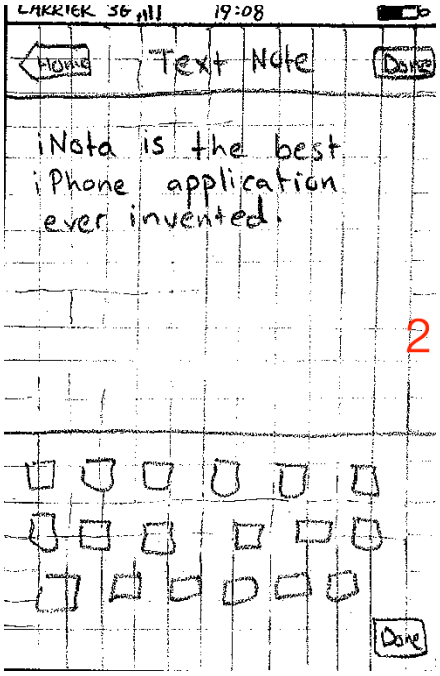
9. To what extent do you agree or disagree with this statement: "The '"Paper in Screen"' technique captures mobile user experience and interaction design elements that would otherwise be found only with high-fidelity or functional prototypes"

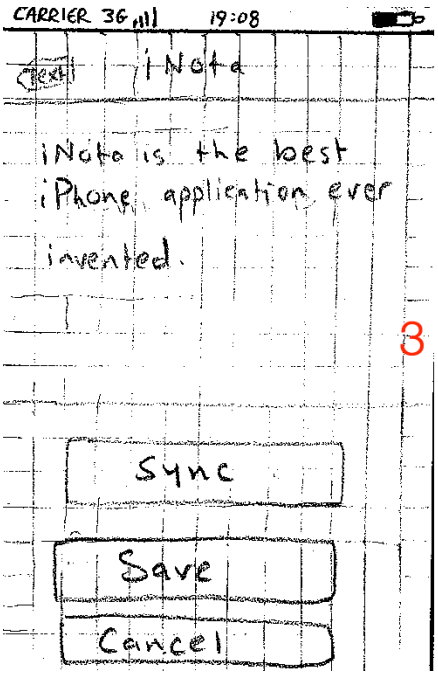
Strongly agree	2	20
Somewhat agree	7	70
Neither agree nor disagree	1	10
Somewhat disagree	0	0
Strongly disagree	0	0
No opinion	0	0
	0	0

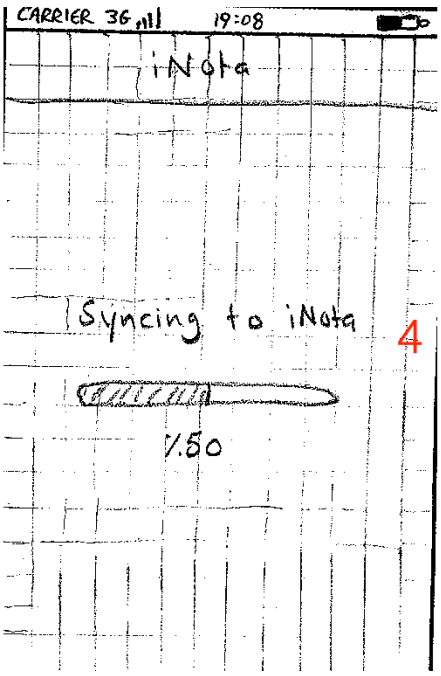
Appendix E: Paper Prototypes Made by Participants

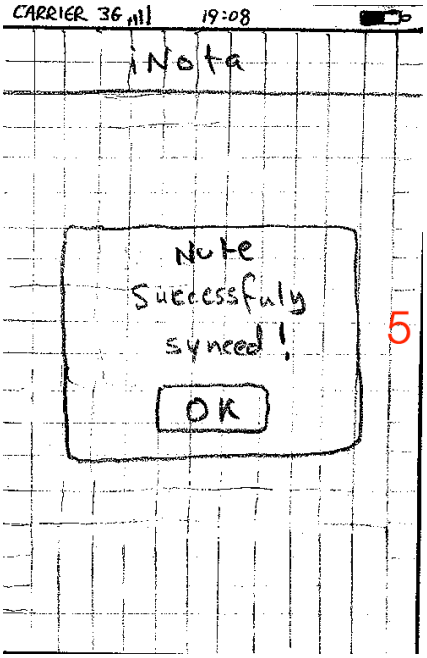
iNota Text Scenario



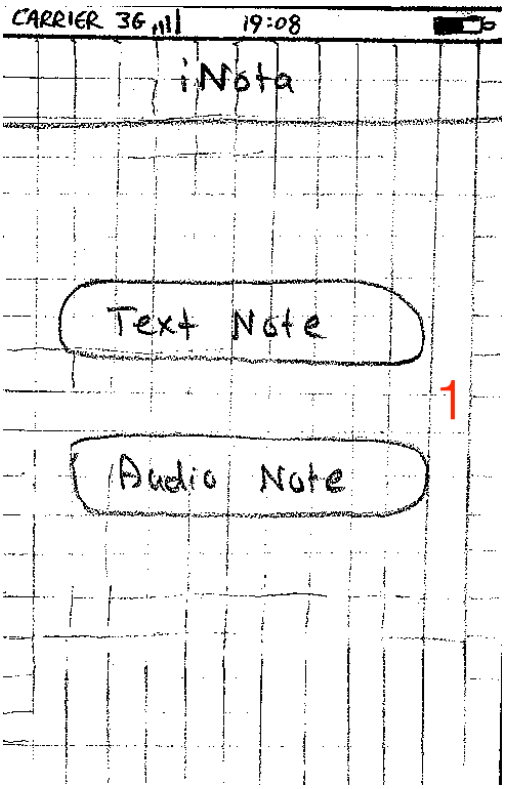


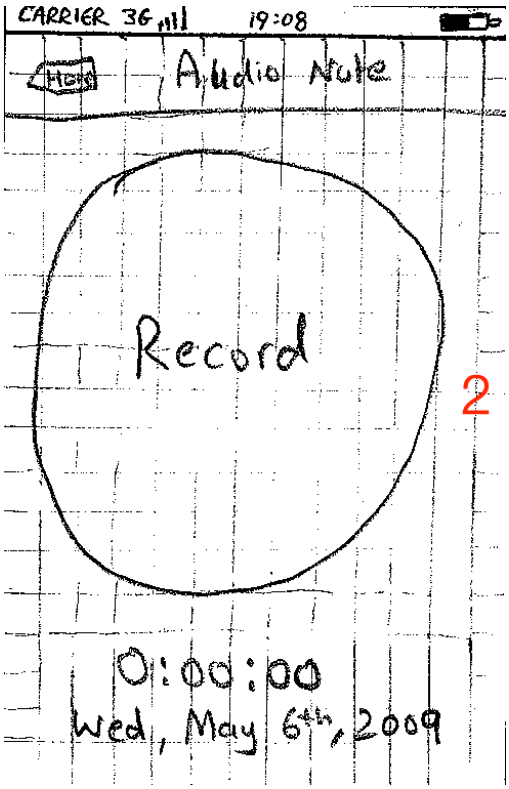


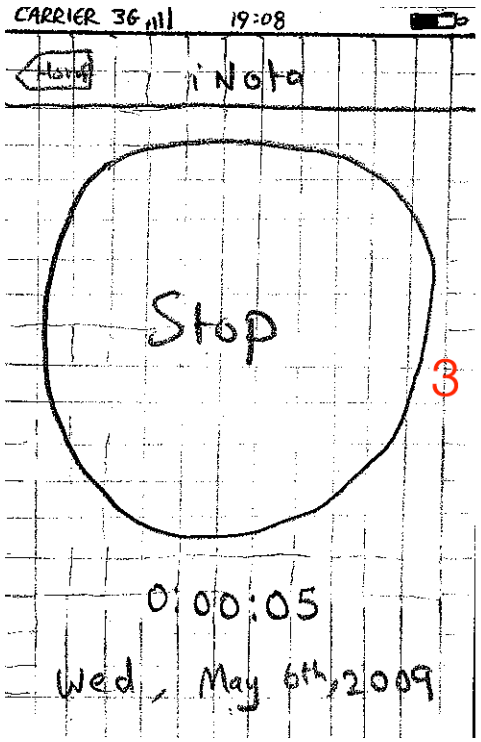


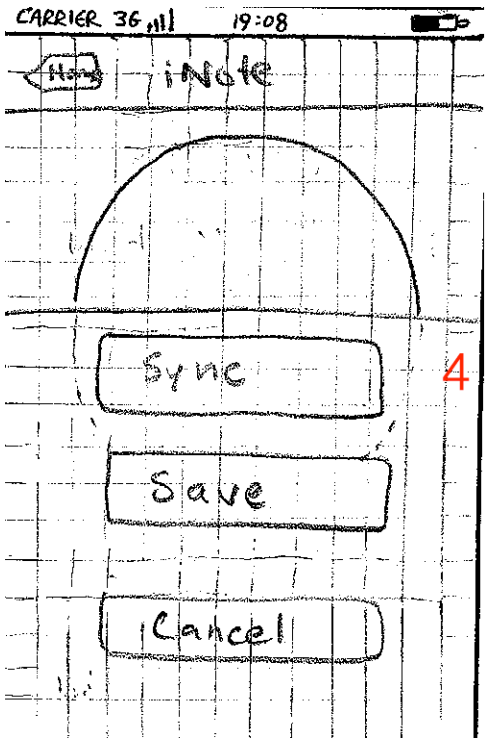


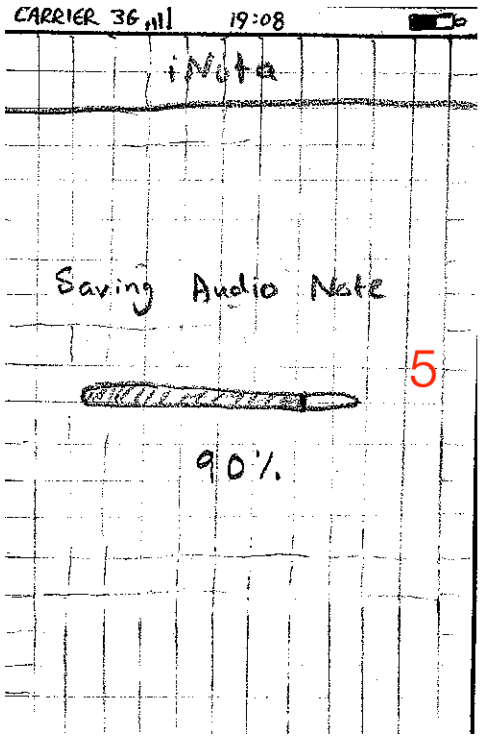
iNota Audio Scenario

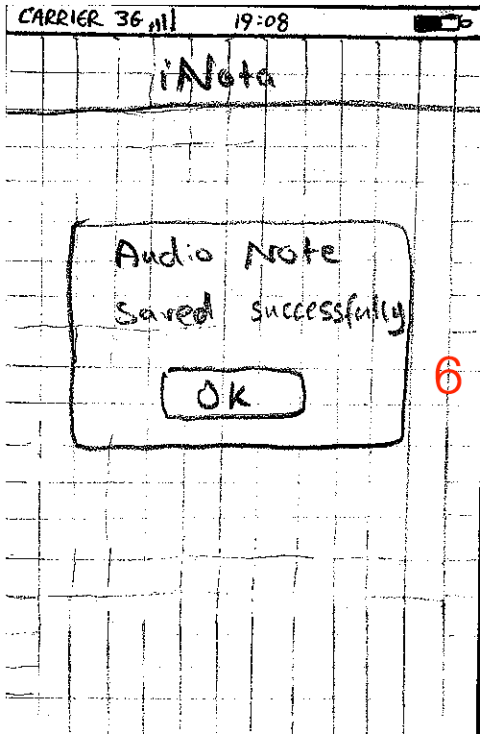





CARRIER 36
19:08
Home
iNote
Stop
3
0:00:05
Wed, May 6th, 2009


CARRIER 36
19:08
Home
iNote
Sync
4
Save
Cancel


CARRIER 36
19:08
iNote
Saving Audio Note
5
90%


CARRIER 36
19:08
iNote
Audio Note
Saved successfully
Ok
6

Appendix F: Accepted IRB Form

IUPUI/CLARIAN INSTITUTIONAL REVIEW BOARD (IRB) REVIEW

EXEMPT RESEARCH CHECKLIST

IRB Study #: EX0903.16B

SECTION I: INVESTIGATOR INFORMATION

Principal Investigator: Bolchini, Davide, Assistant Professor **Department: School of Informatics**
(Last, First, Middle Initial------must have faculty/staff status or faculty sponsor must sign)

Building/Room No.: IT Building, Room 485 Phone: 317.278.5411 E-Mail: dbolchin@iupui.edu

Co-Investigator/Student: Pulido, Diego (Ms student) Phone: 317.531.4889 E-Mail: dfpulido@iupui.edu

If this is a Student Protocol, List Name of the Student: Pulido, Diego Phone: 317.531.4889

Project Title: "Paper-in-screen" prototyping: an agile technique to anticipate the mobile experience

Sponsor/Funding Agency: _____ PI on Grant: _____

Sponsor Protocol #/Grant #: _____ Period: From: to

Sponsor Type: ☐ Federal; ☐ State; ☐ Industry ☐ Not-for-Profit ☒ Unfunded; ☐ Internally Funded

Grant Title (if different from project title):

SECTION II: PERFORMANCE SITE

- ☐ Bell Flower Clinic
- ☐ Beltway Surgery Centers
- ☐ Clarian North Medical Center
- ☐ Clarian West Medical Center
- ☐ General Clinical Research Center (GCRC)*
- ☐ IU School of Dentistry
- ☐ IU Cancer Center*
- ☐ IU Medical Group Primary Care Clinic (IUMG-PC), including Wishard primary care clinics
  - ☐ Spring Mill Medical Center
- ☐ IU Medical Group Specialty Clinic (IUMG-SC)
- ☒ IU/IUPUI Campus, Location: 4th Floor, IT building (room 468)
- ☐ Krannert Institute of Cardiology*
- ☐ LaPorte Regional Health System
- ☐ Larue Carter Hospital
- ☐ Lilly Clinic
- ☐ Methodist Beltway Centers
- ☐ Methodist Hospital
- ☐ Methodist-Affiliated Centers/Private Practices
- ☐ Midtown Mental Health*
- ☐ Regenstrief Institute
- ☐ Rehabilitation Hospital of Indiana
- ☐ Riley Hospital
- ☐ University Hospital
- ☐ Veterans Affairs Medical Center**
- ☐ Wishard Memorial Hospital*
  - ☐ Hospital/ER
  - ☐ Non-primary care
    - ☐ Regenstrief Health Center
    - ☐ Wishard Specialty Clinics
    - ☐ OB/GYN Clinics
- ☐ Other:

** Additional information or submission may be required prior to initiating the study. Please check with the specific performance site for additional information.*

***Any study using the VA as a performance site, using VA patients, or funded by the VA MUST be submitted to and receive approval from the VA R&D Committee **before** any research can be conducted at the VA,.*

SECTION III: RESEARCH DESCRIPTION

NOTE: Study information will be released to the Clinical and Translational Science Institute (CTSI) for the clinical trials listing. To opt out of this listing requirement you will need to get opt-out approval from Dr. Anantha Shekhar, PhD, MD, Director of Indiana CTSI, prior to IRB submission. For additional information or to request opt-out approval, please contact Sam Scahill at (317) 278-6969 or sscahill@iupui.edu.

1. Provide a brief description, in lay terms, of the purpose of the proposed project and the procedures to be used.

Purpose of the study: Paper prototyping has proved to be a useful technique to test the initial designs of interactive software applications. Although practical and useful, paper prototyping relies on the use of interface mock-ups made of paper and presented to the user to elicit usability issue with the preliminary design of the interface.
When designing interactive applications for mobile devices, the design and testing of the interface per se is only a small part of the user experience. The interaction with the device itself and the use of the interface as integrated in the device are crucial elements of the user experience. However, traditional paper prototyping does not enable to test the interface *integrated* in the actual device (a cell phone). To date, the only way to test an interface in the actual mobile device is to build more refined, interactive prototype, which is very expensive and time-consuming, especially when numerous design revisions are needed.
We have created a prototyping technique, called "paper-in-screen", that consists in generating paper prototypes, digitalizing them and easily embedding them in a physical mobile device, so that designers can have users try out their interface prototype by using the actual mobile device. The main advantage of the technique for the designers is that it allows quickly generating and testing interactive paper prototypes by anticipating more factors of the mobile user experience, yet without committing resources in implementing more refined prototypes.
The specific goal of the study is to elicit feedback from design and usability professionals about the utility, efficiency and effectiveness of the "paper-in-screen" technique. This preliminary study will serve to test the quality of the technique and to improve it according to the feedback received, in order to make it a useful design tool for the interaction design professionals.

Procedure: Each participant will individually experiment the use of the "Paper-in-Screen" by designing the user interface of a simple note-taking mobile application for the Apple iPhone, as guided and instructed by a facilitator.
As first task, each participant will be instructed on what to design. Then, with the help of a facilitator, s/he will be directed to generate a traditional paper prototype, by drawing on paper the user interface of the application for 2 simple use case scenarios.
After allowing the participant to review the paper prototypes, the "paper-in-screen" technique is introduced and explained. The participant will be then invited to make use of the technique by taking the generated paper prototype, format and digitalize it for the integration in the mobile device, and to incorporate it into an iPhone's screen dimensions. At this point, each participant will be able to appreciate and review the "paper-in-screen" prototype generated, and use it as basis for guided discussion with the facilitator about perceived utility, efficiency and effectiveness of the technique and the process.
Finally, each participant will be administrated a short questionnaire to gather more structured feedback on the newly introduced technique.

a. Please state the eligibility (inclusion/exclusion criteria.)

This study is explicitly looking for usability, interactive media, user experience, HCI design professionals with work experience or good knowledge in user interface prototyping, and, most specifically paper prototyping.

b. Will subjects be compensated for participation?

Participants will not be paid to participate in this study, but everyone who participates in the study will be provided with free pizza and refreshments, during the session. Moreover, participants will be able to take home the paper prototypes a copy of the digital images of the prototypes produced during the sessions, as useful material to review, reuse or illustrate to others the innovative technique of "paper-in-screen".

ONLY COMPLETE 2-4 BELOW IF YOU SELECTED CATEGORY 1, 2, 3, 5, OR 6 ON THE EXEMPT RESEARCH CHECKLIST.

2. Provide the process by which individuals will be recruited.

Participants will be recruited via email invitation sent to members of the Indiana chapter of the Usability Professionals' Association (UPA), in agreement with the UPA chapter president. A second source for recruiting participants will be the personal professional contacts of the Co-PI, including colleagues working in usability and design at Pearson education.
All prospective participants will receive instructions in the email of what is expected from them and they will be asked to reply with a day and a time from a series of available dates. The message will explicitly mention the pizza and refreshments to encourage participation.

a. Explain how it will be ensured that recruitment or selection will not unfairly target a particular population or will target the population that will benefit from the project/research.

The study targets a very specific group of professional users: professionals in the field of usability and user experience with experience or good knowledge in paper prototyping techniques. This is a study that is geared towards validating a new technique that would be valuable for usability professionals to improve the process and effectiveness of paper prototyping. In other words, the main goal is to help professionals in the area perform more productive and significant usability test without much more effort than they are currently aware of. Targeting people with knowledge or experience in paper prototyping will enable the investigators to validate the expected benefits of the "paper-in-screen" technique against the traditional paper prototyping technique, and thus establish a truly innovative and distinctive practice.

3. Explain how it will be ensured that individuals will be treated with respect during interactions/observations with them. For those individuals with diminished autonomy (e.g. children, people with limited ability to make decisions), explain how they will be protected.

   No individual will be excluded from participation on the basis of gender, religion, race, age or sexual orientation. This information will not be collected during the recruitment or during the study. In addition, simple instructions will be given at the beginning of the testing session clearly explaining the purpose of the exercise and that there won't be any recollection of personal or sensible information at any point.

   a. Explain how individual privacy will be protected. For example, if interviewing, where will that be conducted?

      No personal information collected during the testing sessions. All testing sessions will take place in 4th Floor, IT building (room 468) at IUPUI campus. Full address of the location:

      Indiana University
      School of Informatics at IUPUI
      535 West Michigan Street
      Indianapolis, IN 46202-3103 U.S.A.

   b. Explain how individual confidentiality will be protected. For example, what kind of information will be recorded and how will that be protected?

      During the sessions, the audio of the conversations taking place will be recorded and it will be used with the sole purpose of recollecting information that may have been lost whilst taking notes from the informal interview taking place. The audio recordings will not be shared with anyone and will be erased after the project is finished. The questions being asked during the study and the questionnaire completed at the end of the study will never be paired with any of the participant's personal information. They will be completely anonymous.

4. How will you help to minimize potential risks that individuals may be exposed to while participating in the research? Potentials risks may include psychological, social, legal, physical, etc.

   Participants will be clearly reminded that participating to the study is voluntary and if they wish to do so is to help academic research only. They will be reminded that all information provided is voluntary and all questions are optional, and that at any time they may withdraw from the study. They will be informed of this upon beginning the testing session and will be reminded they are allowed to terminate the session at any time, should they have to for any reason.

   In addition, most questions will be open ended, without the need to provide a right answer to any of them. The multiple-choice questionnaire at the end will be directly related to paper prototyping and the "paper-in-screen" technique. Participants won't be forced to answer any question they don't wish to answer, for there will be a "no opinion" option offered for every question in the questionnaire.

   At the end of the survey participants will be thanked and reminded that their participation is useful to contribute to usability, prototyping and mobile interaction design.

Statement of Investigator (or Faculty Sponsor in the case of a student project). I have personally reviewed this application and agree with its contents and am aware of my responsibility to provide supervision and guidance during its execution (in the case of a student project).

Recorded in the Minutes of: _____

Signature: [signature] Date: March 5, 2009

SECTION IV: EXEMPT REVIEW DETERMINATION

☒ Accepted, Exempt Category(ies): 2

☐ Denied, Reason:

Authorized Signature: Regina Winning Date:

Exemption determination reported to: ☒ IRB-01 ☐ IRB-02 ☐ IRB-03 ☐ IRB-04 ☐ IRB-05

Recorded in the Minutes of: APR 03 2009

VITA

Diego Fernando Pulido

dfpulido@iupui.edu
(317) 531-4889
14168 Cliffwood Place.
Fishers, IN, 46038 USA

Education

Master of Science in Human-Computer Interaction, Expected December 2009
School of Informatics, Indiana University Purdue University at Indianapolis (IUPUI)
Thesis: "Paper in Screen" An Agile Technique To Anticipate Mobile Experience
Advisor: Dr. Davide Bolchini

Bachelor of Arts in Psychology/French, May 2005
University of Nevada, Reno, USA

Professional

Interaction Designer, Pearson Education, Indianapolis, IN

Aug 2007 – Dec 2009
Designed the interaction and behavior of educational web sites and internal web-based management systems. Designed task flows, wireframes. Performed heuristic evaluations; contextual inquiries and defined web sites' information architecture for user-friendliness

Research Assistant, Roudebush Veteran Affairs Hospital, Indianapolis, IN

Aug 2006 – Aug 2007
A position under the Research Department of the *Roudebush Veteran Affairs* hospital, focused on improving the usability, look-and-feel and information architecture of its websites.

Skills

HTMLM; XHTML; CSS; PHP; MySQL; Adobe Photoshop; Fireworks; Flash; Illustrator; InDesign; Dreamweaver; OmniGraffle; Microsoft Visio; Microsoft Visual Basic;