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Designing for the Wild

An alternative gesture navigation scheme for mobile devices in wild environments

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Thesis Abstract

When operating mobile devices outside of a controlled environment, standard touch-screen navigation schemes prove inadequate and ineffective. In these wild environments, such as at ski resorts, on lakes and rivers, or in muddy terrain, traditional interaction between the user and the device is greatly hindered due to the adaptations that mobile devices require in these environments. Usability issues arise due to an array of factors, such as weatherproof and protective casings, bulky gear or gloves worn by users, and safety hazards encountered within the environment.

A navigation scheme based on simple user-initiated gestures can reduce the safety hazards and physical challenges that are introduced when interacting with a mobile device in the wild. This scheme eliminates the need for touch-screen mechanics, while providing a better and more effective interaction between the user and the device, regardless of the environmental challenges encountered.

Designing for the Wild

In the past, computing primarily took place in the home or the office. As this became the standard location of use, screen interfaces, such as computers, laptops, cell phones, and similar devices, were created with this context[1] in mind. Despite the advancement of technology and portability of equipment, most interface designs still default to the ideal home and office environment instead of considering all of the actual environments in which the interface will be used. Since the home and office are very clean and controlled environments, little consideration was given to on-the-go environmental factors or additional design constraints that are often presented in varying situations. This genre of design, including contexts that are less than optimal for computing, has been adopted as *design for the wild* (Buxton 27 - 38). The traditional practice of designing for ideal environments has carried on, even though the contexts of computing have drastically changed and expanded throughout the 21st century.

Mobile technology has specifically added to the plethora of contexts for designers to consider. Its anywhere, anytime accessibility has increased ubiquitous computing, and has created a new set of design considerations and standards. Transitioning from earlier designs that were displayed on privately used mobile phones, the smart phones of today are used as personal digital assistants (PDAs), maps, global positioning systems (GPS), web browsers, game consoles, cameras and more. Brian Fling mentions in the book *Mobile Design and Development*, "Mobile devices, unlike any other medium, present an amazing opportunity to create contextual, meaningful experiences unlike anything we've ever seen" (55). Since mobile applications can be accessed in this anywhere, anytime manner, the designer is faced with numerous design

[1] Context can mean many things, but in relation to human-computer interaction, context refers to the location or environment in which an interface is used.

challenges and context-based decisions. While mobile phones are still used in the home and office, we also see them used in additional contexts as social networking tools, web browsers, for travel purposes, gaming, and many other uses during our daily routines. In the past, such uses of our mobile devices were often overlooked or disregarded, as designers defaulted to the traditional standards of home and office interface design techniques. The benefits of context-based designs are highly used within the mobile realm, but the actual design considerations and constraints that accompany them are very much overlooked and misunderstood. With the popularity of mobile devices continuing to rise, people are beginning to see the importance of context as a vital player in the success of a mobile application design. Design considerations for environmental factors such as weather, lighting, noise, space, and portability become issues that were once non-existent for devices in the home and office. The context in which users interact with these mobile devices becomes a focus for designers since these environments drive the design of the device. "My physical context influences my actions; whether I'm at home, in the office, in a car, on a bus or train, walking the streets… each environment will dictate how I access information therefore how I derive value from it" (Fling 52).

Users are accessing mobile devices at increasing rates in less than ideal environments, which have been coined *wild environments*. Bill Buxton, one of the most notable pioneers in the field of human-computer interaction, explains this type of design in the book *Sketching User Experiences*:

> The type of design that I want to talk about… gets down and dirty. It is design for the real world – the world that we live in, which is messy and constantly changing, and where once a product is released, the designer, manufacturer, and vendor have virtually no control or influence over how or where it is used. Once sold, it leaves the perfect world of

the glossy advertising photos. In short, I am talking about design for the wild. (97)

This thesis specifically focuses on the use of mobile devices in the context of wild environments, as these situations present numerous design constraints and usability issues that have yet to be resolved.

Within the contexts of wild environments, application designers and developers are presented with new and unique challenges, such as inclement weather, safety concerns, and interaction challenges. The need for context-based solutions is constantly growing, but application developers have yet to find a software solution to the human-computer interaction issues that arise due to an array of factors presented within these environments. These factors include elements such as moisture and terrain, weatherproof cases, or bulky gear. Although previously not given the attention it deserves, the topic of context is slowly beginning to rise to the forefront of design considerations. Jay David Bolter and Diane Gromala point out the importance of this element in the book *Windows and Mirrors* when they stated, “Designers need to understand and care about the contexts in which their designs will function” (122).

Prior attempts at resolving these issues can be found within hardware adaptations and software modifications, such as protective cases, special gloves, or accelerometer based gaming mechanics (which will be elaborated on further in the *Prior Solutions* section of this paper). Although these efforts do prove beneficial in some environments and situations, they do not solve the problem as a whole, or address the primary concern of requiring touch interaction with the mobile device screen as the primary input mechanism. Touch interaction with the screen produces obvious issues, such as smearing, scratching, or damaging the sensitive hardware, along with dropping the device or being unable to interact with the screen due to bulky gear. Since this traditional touch navigation for mobile applications proves ineffective in wild environments, an alternative gesture navigation scheme is needed to facilitate the navigation of application features in less than ideal environments. This will eliminate the need for interaction with the touchscreen. It will also reduce safety hazards and physical challenges that are introduced when interacting with a mobile device in the wild. Finally, it will provide a better and more effective interaction between the user and the device, regardless of the environmental challenges encountered.

Problem Statement

As Dan Saffer notes, “Start with the needs of those who will use it” (16). I first observed the usability issues that arise when accessing mobile devices in wild environments when I was snowboarding with a group of friends. As we rode the ski lift up the mountain, my friends removed their gloves, unzipped their jackets, and removed their mobile devices from their interior coat pockets. Then they began to perform numerous touch interactions with the mobile device screen with much difficulty. They continued to struggle as they attempted to perform tasks such as changing a music playlist, texting a friend, checking the weather forecast, or viewing a digital map of the mountain. They were smearing moisture on their sensitive device screens, having difficulty performing touch interactions with cold and less than nimble fingers, struggling to read the mobile screen because it was beginning to fog, and were having trouble holding their gloves in their lap or armpit while attempting to operate their mobile device with two hands. Often times, this lead to almost dropping the device into the snow below, barely getting the phone into their pocket in time to safely navigate off the lift, or dropping a glove or piece of equipment due to having to operate the mobile device with both hands.

After further analysis on these usability issues, I began to notice that the interaction problems arise due to an array of factors and adaptations that mobile devices require in these situations. Environmental elements (moisture, terrain, etc), weatherproof and protective cases used to shield the device from harsh environments, bulky gear or gloves worn by users, and safety hazards encountered are often introduced within these environments. These factors create additional design constraints that must be addressed due to the context of the interactions by the user.

The consideration of how the information is accessed becomes vital in the development of mobile applications for on-the-go activities. “Context is core to the mobile experience” (Fling 116). A user’s interaction with an interface is different in dark situations compared to light, rainy situations compared to dry, and so on. Eric Bergman notes this in his book *Information Appliances and Beyond* when he states, “Varying lighting conditions, from direct sunlight to complete darkness, require careful display design… Varying climate and weather conditions may require, for example, water resistance to some extent or the ability of the user to wear gloves” (178). These environments, along with the hardware adaptations that are often necessary during on-the-go activities, present a new set of unique design challenges.

In order to properly protect mobile devices from harsh environments, such as rain, snow, or mud, users often secure their phones in protective cases. These cases can be large and clunky, and make it harder for the user to interact with the touchscreen. Things like wet hands, rain, sand, or other elements and environmental factors can damage the sensitive hardware of the mobile device. “Fingers are also just messier and more inaccurate than cursors… Human fingers are an imperfect input device…” (Saffer 40). These environments also often necessitate the wearing of bulky gear and other protective material. Users cannot be expected to remove this equipment to operate their mobile devices, as in certain harsh environments this proves impossible or unsafe. Dan Saffer notes, "Gloves, too, can make it difficult to use gestural interfaces. Not only do they usually inhibit hand movement and increase finger size, but they also may not trigger capacitive touchscreen because they do not conduct electricity" (39). Since capacitive touchscreens cannot be triggered through standard gloves, the user is forced to remove them in order to operate their mobile device. Removing gloves means cold hands, less nimble fingers, safety concerns, and a higher level of annoyance for users.

Another issue to consider is that wearing bulky gear often only allots the user to operate their mobile device with one hand. A standard of mobile phone design in relation to human computer interaction is the ability to operate the device with one hand (Bergman 188). This proves true during *on-the-go* activities such as skiing or kayaking, where the user must hold poles or a paddle in one hand, while operating their mobile device in the other[2]. This also presents many safety concerns. In wild environments like ski resorts, users are often accessing their mobile devices on lifts at great heights. Users cannot be concerned with removing their gloves, holding their poles, and operating their mobile devices while attempting to safely ride a ski lift.

Touchscreen devices are commonly operated on a traditional touch gesture scheme. This includes gesture interactions such as *tap*, *touch-and-drag*, and *pinch-and-squeeze*. Although these interactions suffice in clean and controlled environments, due to the factors and usability issues discussed above, standard touch-screen navigation schemes prove inadequate and ineffective in these environments. "Designers need to take into account the probable environment of use and determine what, if any, kind of gesture will work in that environment" (Saffer 17). Since the traditional gesture scheme does not suffice in numerous wild

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[2] The same design considerations can be applied to contexts of other activities such as shopping or traveling in airports where most users have one hand dedicated to carrying bags or luggage.

environments, a new gestural scheme for mobile devices must be considered in order to alleviate these usability concerns[3]. Many commercial products aim to solve this issue through hardware adaptations, but fall short in a variety of ways and create numerous usability issues of their own. Software modifications that minimize touch interaction with the mobile device screen show capabilities for an alterative gesture navigation scheme, but do not fully implement the touchscreen-free navigation as a primary input mechanism. We can see this by taking an in-depth look at the prior solutions for this human computer interaction issue.

Prior Solutions

The use of mobile devices in wild environments brings about numerous usability challenges, due to the reliance on touch interaction with the mobile device screen as the primary input mechanism. When we take a look at the history of this problem, we find numerous hardware solutions that attempt to protect the device and the user from harsh environments. We also find a small amount of software capabilities that could be used and expanded upon in order to minimize touch interaction with the mobile device screen. Accelerometer based gaming mechanics, along with gestural controls that have been implemented within music players and photo viewers, begin to paint a picture of what could possibly be the future of touchscreen-free mobile navigation for wild environments. When combined with the hardware adaptations currently available, a solution for interacting with mobile devices in wild environments becomes a reality.

[3] While some designers suggest the use of voice command technology, this is not optimal in all wild environments, as some entail loud noise levels or wind factors that must be considered.

Prior Solutions: Hardware

Hardware solutions that attempt to protect the user and the mobile device in harsh environments include the production of rugged devices, weatherproof and protective cases, and special gloves. Although these attempts help minimize some of the usability issues that arise in wild environments, they also present numerous challenges and issues of their own.

An emerging phenomenon has begun within the mobile community as phone manufacturers are beginning to acknowledge the increasing use of mobile devices in wild environments. Due to the need demonstrated by consumers, manufacturers have started to release rugged devices to help suit the wild environments in which they are used. The Android Defy is a good example of the market acknowledging this, as the phone comes standard with a water resistant, dust proof, rugged exterior that helps shield it from the surrounding environment (Hannaford). Priya Ganapati wrote in the *Wired Magazine* blog,

> The devices are part of an emerging category of rugged phones aimed at people who are rough on their gadgets… Major handset makers including Nokia and Samsung, as well as specialized handset makers such as Sonim, are counting on these near-unbreakable phones to reach a section of consumers–plumbers, construction workers and truck drivers, not to mention mountain bikers and snowboarders… (Ganapati)

These rugged devices are a step in the right direction for mobile hardware, but the added ease of mind and safety that these devices provide come with numerous disadvantages as well. To start, these devices have not yet been widely accepted by the mass market, and therefore are only available through a few select carriers in select countries. They also lack some of the features normally offered as standard on other similar devices, such as a high megapixel camera, touchscreen, and video camera. The phone itself is typically much bulkier than the thin and sleek designed competitors and these rugged devices usually come at a higher price; often nearly double that of standard mobile devices.

A solution for mass-market mobile devices includes special protective casings to help shield the sensitive hardware of mobile devices from harsh or inclement environments. The *Otterbox* series is a set of commercial products that seeks to solve this issue, as they offer numerous shock, dust, and water resistant cases (Find). iTunes offers numerous wearable options, including winter jackets with built-in iPhone/iPod cases. You can also find many plastic bag-like solutions, whether that be an expensive *AQUAPAC Waterproof Mobile Phone & iPhone Case* that comes equipped with an "ultra-secure, rustproof, injection-moulded plastic seal" (Aquapac), or a simple home-made *Ziploc* bag which is often seen as an attempt to shield the device from falling rain or snow.

These solutions tend to cost less than rugged devices, but often do not provide as much ease of mind or security for the device. Moisture tends to still find its way into the case and fog the mobile screen. "The No. 1 device killer is water… Water lingers inside devices and starts to corrode them" (Morisy). These cases are usually water-resistant, not waterproof, so they cannot offer the device complete protection from moisture. This moisture makes it harder to see and interact with the screen, and can damage the device. Bulky cases present numerous usability issues, as they make it harder to interact with the touchscreen. The thick plastic of the case that covers the screen makes it more difficult to trigger the capacitive touchscreen. For environments that necessitate this type of protection, there is no way to trigger capacitive touchscreens, as gear and cases both inhibit touch interaction with the screen.

A third solution that has popped up around the market is the release of special gloves with conductive fingertips to trigger capacitive touchscreens through the glove material. The

FREEHAND Tech-Tip Gloves offer, “Waterproof, triple-layer liner features conductive silver-nylon tips on the thumb and forefinger and works with any touch-screen device” (FREEHANDS Tech-Tip). *Freehand*, along with numerous other companies, also offers gloves with overlapping finger caps so the tips can be removed to operate mobile devices (FREEHANDS Men's). A similar, yet cheaper, solution users have begun to implement themselves is simply cutting the fingertips of their gloves off completely, in order to have their fingers out and ready whenever needed to trigger the touchscreen on their mobile devices.

Although these special glove solutions sometime solve the issue of having to remove gloves to operate mobile devices in wild environments, they still require touch interaction with the screen as the primary input mechanism and do not protect the device in any way from elements within the environment. If the user’s gloves are wet or dirty, they can damage the mobile screen just like bare hands. They can smudge the screen and make it harder to read and interact with. “Fingers also have natural oils and/or can get slippery, which can make it tricky, if not impossible, to manipulate things. Touchscreens, too, can get oily and worn, making them difficult to use. Finger oil (and dirt) also means fingerprints and smudges” (Saffer 39). This can damage the sensitive hardware of the device. Also, the removable finger caps on several of the glove designs are not applicable to all environments. In extremely harsh environments, removing the fingers of gloves would prove dangerous and could become a safety concern. Cutting off the glove fingertips presents obvious concerns, as environmental factors can easily enter the inside of the glove and cause similar safety concerns. With this homemade solution, there is still the concern that the user’s hands will be wet or muddy from interacting with the environment. This can damage the mobile device when interacting with the screen, not to mention that the expensive gloves are practically useless once the fingertips are cut off.

Another main concern is that these glove solutions are often simply soft shell gloves, very lightweight and not very warm. They require a heavier pair of gloves be worn over them for colder, harsher environments (FREEHANDS Tech-Tip). In these situations, the tipped gloves do not solve any usability issues, as the user is still forced to remove their outer pair of gloves, to expose the tech-tip gloves beneath in order to interact with the mobile device screen.

Each of these hardware solutions attempt to address one aspect of the physical concerns that arise when using mobile devices in wild environments. Although the attempts do alleviate some of the concerns noted, they by no means solve the problem as a whole or address the most important issue of requiring touch interaction with the screen as the primary input mechanism. A realm of mobile development that does show a glimpse of removing touch interaction with the screen can be found within software modifications.

Prior Solutions: Software

Touchscreen-free interaction with a mobile device has been established at varying degrees through software modifications. Accelerometer-based gaming mechanics have been implemented in smartphone games[4] to limit touch interaction with the screen, a shake gesture has been added to mobile music players to control playlists, and an orientation change gesture has been developed to allow the user to switch between viewing modes. Each of these software innovations show the possibilities that lie within gestural technology to eliminate touch interaction with the mobile device screen, even though they were not created in a direct attempt to alleviate the usability issues that arise for mobile devices in wild environments.

The accelerometer has predominantly been explored for use in game development for

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[4] While the accelerometer is still a hardware addition, it has become quite commonplace within many mass-marketed mobile devices such as the Android and the iPhone. These brands alone combined for over 64% of the U.S. smartphone market share in 2011 (NielsenWire).

smartphone games. These accelerometer-based games allow players to interact and control elements within the game without having to touch the mobile device screen. Ricky Buchanon noted this in an article about iPhone games that use alternative inputs when he stated, "The iPhone and iPod touch come with very accurate accelerometers – the programs which are running can know when the device is being moved, and how much/how far/which direction it's being moved. Game developers have taken advantage of this capability to develop some games, which just rely on the device being moved or shaken" (Buchanan). You often see this mechanic in games that implement the elements of gravity and velocity, such as rolling a ball around the screen, or flying a plane through an environment.

Two well-known examples of accelerometer-based mobile games include titles such as *Super Monkey Ball* and *Tilt Fighter*. In *Super Monkey Ball*, the user tilts their mobile device to control the movement of the monkey on the screen. The goal is to safely navigate the character past obstacles and dangerous elements such as drop-offs, ledges, and moving platforms. As Buchanan explains, "With a pinpoint control mechanism, players will simply tilt and turn the device to maneuver their monkey, accelerating and decelerating as they make their way through the colorfully animated world" (Buchanan). This accelerometer implementation has been used purely as a gaming mechanic, and not as an overall navigation scheme. It has been implemented to create a more natural and enjoyable experience, but not in a direct attempt to remove interaction with the touchscreen to alleviate usability concerns. These games often implement touch mechanics for all other input mechanisms, other than to control one object within the game. In *Tilt Fighter*, the user tilts their mobile device to control the movement of a spaceship on screen in attempt to successfully navigate around harmful asteroids and enemy bullets. The user further interacts by tapping and performing a *pinch-and-squeeze* gesture on the screen to control the spaceship's weapons, such as shooting the laser cannons or launching bombs (Buchanan).

As you can see, the accelerometer implementation within *Super Monkey Ball* and *Tilt Fighter* is used as the main control mechanism, along with numerous other touch mechanics built in around it. These games introduce the possibility for touchscreen-free mechanics, but only go so far in their implementation of the accelerometer as a primary input device. This implementation would by no means suffice in wild environments, but it does show the capabilities for accelerometer input in creating a touchscreen-free input method. The music industry, specifically Apple and iTunes, has implemented their own use of the accelerometer.

Apple and iTunes have implemented numerous touchscreen-free gestures in order to control music playback. In order to create a more streamlined input mechanism, Apple introduced a shake gesture as a quick and easy way to shuffle through a playlist. This gesture control was introduced on 4th generation iPods and newer (IPod), and was coined *Shake to Shuffle* (One-tap)**.** This created an easy and efficient way to switch to the next song without having to unlock the device and interact with the touchscreen. The user can simply shake their device from side to side as it automatically shuffles to a new song. This design change was likely made in order to support the use of the music players during activities such as jogging, riding trains, lifting weights, or during other on-the-go activities.

Another common gesture used within the iPhone is an orientation change. Selected as one of the ten best features of the iPhone, Siddharth explains this feature by saying, "When we turn the iPhone by 90 degrees, the iPhone automatically detects it and rotates the screen view" (Siddharth). This orientation change can be applied to things like photos, videos, applications, and web browsers. As you will see within the alterative gesture navigation scheme created within this study, the orientation change can also be translated into depth flips (aligning the phone parallel with the ground), compared to that of the traditional ninety degree rotations to each side.

By combining the software capabilities of accelerometer based tilts, shakes, and orientation changes, with the hardware adaptations of rugged devices or weatherproof and protective casings, one can see the future of mobile interaction for wild environments. A complete gestural navigation scheme removes the need for touch interaction with the mobile device screen, and alleviates the usability issues experienced in wild environments. We must "design the system to suit the needs of intended users" (Bolter and Gromala 139). In order to minimize the need for touch interaction with the mobile device screen, a new gestural navigation scheme for mobile devices must be created out of existing paradigms, technological innovations, and the software capabilities discussed above. In order to create the future for touchscreen-free mobile navigation, one must first understand the past.

BRIEF HISTORY OF GESTURAL INTERFACES

In order to predict and implement the future of gestural navigation schemes in mobile devices, one must understand how past technologies came about. As Bolter and Gromala state, "As designers, we need to understand how our work functions in the history of media precisely because we are both doomed and privileged to repeat that history in our designs" (85). Noting each of these individual contributions to computing also provides context for earlier paradigms of interaction design, which focused around the ideal environments of the home or office.

Touchscreens

The first graphical user interface (GUI) was released in 1963, with the debut of Ivan Sutherland's *Sketchpad* (Sketchpad). This invention allowed the user to directly manipulate[5] objects on the screen. This revolutionary innovation in the field of human-computer interaction won the device numerous awards and acclamations. The Sketchpad "anticipated many of the interaction conventions of direct manipulation, including clicking a button to select a visible object, and dragging to modify it" (Sutherland 3). Douglas Engelbart prototyped the first *mouse* control input to be used with a GUI in 1964 (Bellis). Although this innovation moved away from direct manipulation, the point-and-click paradigm still exists today in modern computing where the primary input is an indirect manipulation of the screen requiring hand-eye coordination. The use of the *click* as an input mechanism natural progressed into the *tap* gestural input we see today used with touchscreen devices. As you can see, these input mechanisms were slightly adapted, but were still meant for use within the ideal environments of the home or office. This was shortly followed by the development of the first notebook computer. Alan Kay created the concept for the *Dynabook* in the early 1970's, which provided the first look at personal computing for everyone; where the user could access information in his or her own way (Wardrip-Fruin and Montfort 393). The Dynabook brought about ideas of mobile computing, where the user is no longer tied to a desktop computer in their home or office. This characteristic is exemplified in the portable touchscreen devices of today, much resembling touch tablets such as the Apple iPad, or Motorola Xoom.

[5] Ben Shneiderman coined the term *direct manipulation* in 1974, encompassing the computer's new ability to move beyond traditional punch cards and written statements to a new form of direct interaction (Wardrip-Fruin and Montfort 486).

Samuel Hurst released the *Accutouch* in 1977, which is considered the first touchscreen[6] (Krakowsky). This input mechanism was revolutionary for its time, and bridged the gap between the traditional mouse input, to that of a more direct manipulation with the use of gestural inputs. In the 1980's, touchscreen devices became readily available to the general public. We began to see touchscreens implemented for "commercial and industrial use, particularly in point-of-sale (POS) devices in restaurants, bars, and retail environments" (Saffer 8). As this technology became standard, users got more familiar and comfortable with, what is now considered, the traditional gesture scheme. As this became the norm, direct manipulation was taken to the next level through the implementation of multi-touch capabilities.

Multitouch

In 1982, Nimish Mehta finalized his master's thesis at the University of Toronto: the *Flexible Machine Interface*, which was considered the first multitouch interface (Saffer 8). The *HP-150* was released in 1983, as the first computer featuring a touchscreen (Krakowsky). This touchscreen computing technology was combined with Mehta's multitouch capability to create the first multitouch laptop computer in 2007: The *HP Pavilion TX1000 Series Tablet PC* (Lifeofthetouchcreen). This innovation was shortly followed by the *Microsoft Surface Table*, which became available for commercial use in 2008 (Saffer 11). As these technologies continued to grow and expand, their implementation in mobile devices also began to make its mark on history.

[6] Samuel Hurst began the development of the first touch technology in 1971, when he released the *Elograph*, which stands for *Electronic Graphing Device* (History). Over the next 6 years, this technology was expanded upon, and in 1974 the first five wire resistive technology was introduced (Saffer 7). This technology is still popular in touchscreen devices today.

Smartphones

Smartphone technology began in 1994, when BellSouth partnered with IBM to create *Simon* (Krakowsky). This portable touchscreen device combined the technology of a mobile phone, pager, PDA, and fax machine[7] (Krakowsky). Since the debut of Simon, the mobile phone industry has never been the same as smartphone devices now dominate the market. A sleek, and innovative, 21st century version of Simon marked a pivotal day in the history of smartphone devices. This innovation particularly defines this genre of technology: the release of the Apple iPhone in 2007. Fling noted the impact of this when he said,

> I insist that we will look back on the iPhone as one of the most significant milestones that the mobile industry has ever seen. In fact, I believe that in the future, when we reflect on the history of mobile technology, we will divide it into the days before the iPhone and the days after… (Fling 10)

The iPhone's debut was so pivotal in the history of smartphone devices because it bridged the gap between computers and mobile devices. It offered a portable solution that included gestural input, revolutionizing the traditional inputs of the mouse and keyboard. It brought a gestural scheme to everyday mobile users, and raised the bar of what interaction with a mobile device should be.

After the release of the iPhone, numerous competitors jumped on the smartphone bandwagon and followed closely in the iPhone's path. In 2009, Verizon launched the highly successful Motorola Droid (Lifeofthetouchcreen). In 2010, Google released the Nexus One, Verizon announced its new HTC Droid Incredible, and Sprint launched the HTC Evo 4G (Lifeofthetouchcreen). Before we knew it, the age of the smartphone was underway. As

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[7] Simon offered features we still see today, such as the calendar, calculator, world clock, email, address book, and simple games (IBM).

touchscreen devices continued to advance, they began to accept a wider and more complex set of gestures. These devices took the concept of direct manipulation to a new level, and provided users with a gestural interface that became commonplace in their daily lives. If the era of the first mobile devices could have seen the smartphones of today, they would have thought the devices looked like something from a science fiction film. "Science fiction is a great place to explore creative visions of what future interfaces with computers might look like" (Baumgartner and Saito 15).

Gestures

Technological innovations have often been inspired by science fiction. Items like the first mobile devices, touchscreen interfaces, and gestural technologies could be seen in sci-fi films long before they were ever available on consumer shelves. A prime example of this was shown in the 2002 film, *Minority Report*, with its visualization of gestural interaction and direct manipulation (Saffer 1). "The movie *Minority Report* where the main character effortlessly interacts with a holographic screen with point-and-wave gestures is often listed in particular as inspiration for developers…" (Baumgartner and Saito 15). This display of full body, gestural direct manipulation may have been inspired by Myron Krueger's 1974 project entitled, *Videoplace* (Nimoy). Krueger was the first to provide a means of gestural interaction in which traditional inputs, such as the keyboard and mouse, were eliminated. The system functioned purely on gestural input captured by camera vision techniques. The use of sensory data and natural interaction methods, showed a means to remove touch interaction with the screen. This closely resembles the capabilities now available within smartphone devices, thanks to the implementation of an accelerometer and gyroscope.

These types of innovations naturally paved the way for Jeff Han's *multitouch reprojected drafting table* at the TED conference in 2006 (Saffer 1). Han wowed the crowd with his playful and almost magical performance of multitouch gestures and direct manipulation. This demonstration was considered the most profound of the early multi-touch technological innovations (Kelly 4). The table's ability to detect varying levels of pressure and gestural inputs was remarkable, and set the standard for multi-touch interfaces[8]. From the basic touchscreen technology of the 1960s, to the multi-touch, pressure sensitive, interactive tables of today, the world of the touchscreen in human computer interaction has come a long way, and still has room for improvement and innovation.

Advanced gestural technology proves to be the missing link in solving the human-computer interaction issues for mobile devices in wild environments. The advanced technology now available within these devices, from the long line of innovations discussed above, allows for the input of gestural interaction beyond the simple touch gesture schemes of the past. By limiting touch interaction with the screen and relying on a natural gesture scheme, we can eliminate the usability issues found when accessing mobile devices in wild environments. By accessing the smartphone accelerometer, users can perform advanced gestural input to control mobile applications. "Great designs are not unlike great leaps forward in innovation. They come from shredding the baggage regarding how things are done and focus on giving people what they want or what they need" (Fling 115). Users need a solution for interacting with

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[8] Dan Saffer summarized the progression of innovation in gestural technology when he stated, "Technological, social, and market forces have converged to create a fertile new ground for designers and engineers to plow. The price of processing speed has dropped and sensors are readily available. Touchscreens on our mobile devices, ATMs, and airline check-in kiosks have taught us to expect to be able to manipulate things on-screen with our hands. Games have shown us we can make gestures in space to control objects on–screen. Public restrooms are, believe it or not, test laboratories for interactive gestures… All of these things have ushered in a new era of interaction design, one where gestures on a surface and in the air replace (or at least supplement) keyboards, mice, and styli" (Saffer xv).

mobile devices in wild environments. The creation of this alternative gesture navigation scheme solves this issue.

The series of innovations listed above have lead to an additional issue that must be addressed in relation to the development of a gestural navigation scheme. This technology has brought about the overuse of gestures within our current society. This recent fad, which has become a universal solution for numerous user interface and human computer interaction challenges, is a rising epidemic that has escalated since the days of *Minority Report*. This problem has been fueled by the release of new, widely accepted and available, gestural recognition software such as the XBox Kinnect, Wii, and Playstation Move.

We now see gestural interaction in numerous commercial products, such as the Kinect-enabled Xbox 360 Netflix gestural controller (Gilbert). This system offers the ability to "launch Netflix from the Kinect Hub and select from one of the recommended titles using your voice and hand gestures as the remote control…" (Gilbert). This addition to the Xbox console was made in an attempt to be "the only place to experience controller-free entertainment" (Gilbert). As our current society finds itself in a constant race to be the first to offer the next big technological innovation, designers must be cautious in selecting and implementing an interaction model for their designs. The Xbox addition of gestural input may prove unbeneficial or unnecessary, along with numerous other gestural solutions that are being seen implemented into everyday products. At times, a simple button press is still the most effective interaction model. Designers must not rule this solution out just because it is the older, more traditional solution.

On April 1, 2011, Google released an April Fools' hoax mocking this rising gestural fad. They coined the hoaxed email system "Gmail Motion" (Google). "Gmail will enable your webcam when you sign in and automatically recognize any one of the detected movements via a spatial tracking algorithm. We designed the movements to be easy and intuitive to perform…" (Google). Based on the massive response this Google hoax received, it is evident how much interest surrounds the topic of gestural input within our current society. Just as Google showed gestural control of an email system to be unnecessary and slightly comical, gestural control of a video menu may also prove unnecessary as well.

When a legitimate human computer interaction issue arises, designers must seek out the most effective and appropriate interaction scheme possible for users, not just the next rising fad. For the use of mobile devices in wild environments, a gestural navigation scheme was chosen based on sound research, user testing, and the software constraints within current mobile devices. A gestural scheme proved to be the best option and sets itself apart from the rising gestural fad by basing the decision around the user, not the latest technology.

METHODOLOGY

In the book *Designing Gestural Interfaces*, Dan Saffer details the steps required in order to successfully document and create a gestural interface. Within the pages, he maps out numerous steps in the design process. Most notably, he includes identifying a need, creating use cases, documentation, scenarios, task lists, task analysis, gestural vocabulary document, wireframe, prototyping *(low and high-fidelity),* and testing (Saffer 16 - 120). This organization of steps and design processes was used as the backbone for the creation of the alternative gesture navigation scheme for mobile devices in wild environments. Saffer is a famous designer, speaker, and author in the field of interaction design, specifically that of gestural interfaces. “Millions of people every day use the products Dan [Saffer] has designed, from mobile devices to websites to desktop software” (O’ReillyMedia). Based on these credentials, Saffer’s text was chosen to help guide the development of this alternative gestural navigation scheme. As stated earlier, the hardware and software solutions that have attempted to solve the usability issues that arise for mobile devices in less than ideal environments have not yet addressed the primary concern of touch interaction with the mobile device screen as the primary input mechanism. The creation of this alterative gesture navigation scheme for mobile devices in wild environments aims to solve this problem within the field of human computer interaction.

Identifying a Need

After first observing this problem while riding a ski lift with numerous friends who were attempting to access and interact with their mobile devices, I began to take a look at other wild environments that suffered similar issues: such as sand damaging mobile hardware while being used at the beach, canoe and kayakers struggling to operate their device while holding a paddle, and users hunching over their mobile phones or covering them with a *Ziploc* bag in order to operate the devices in conditions with increased moisture. After researching current solutions for this problem, numerous hardware adaptations were found, as well as a few software modifications that show capabilities to alleviate these issues. Although the current solutions address some of the problems encountered, they fall short of addressing the primary concern of requiring touch interaction with the mobile device screen as the primary input mechanism. After realizing this, the specific human computer interaction issue was identified. It required creating an alternative gesture navigation scheme, to eliminate touch interaction with the mobile device screen and therefore alleviate the usability issues that arise when accessing mobile devices in these types of environments.

Use Cases, Documentation, Scenarios, and Task List

In order to understand what type of interaction would best suite the use of mobile devices in wild environments as a whole, a case study was implemented that focused on a specific wild environment and the audience who access mobile devices within it. An environment was selected that presented numerous environmental challenges often encountered in wild environments as a whole, such as moisture, bulky gloves and gear, varying lighting conditions, the use of protective cases, and safety concerns. The core study was able to be extrapolated upon in relation to other wild environments that are encountered during *on-the-go* activities such as snowboarding, kayaking, mountain climbing, hiking, dirt biking, and so on. The specifications of this core study will be explained in further detail later in this paper.

In order to understand the end user of the gestural navigation scheme, a questionnaire was administered to target audience members pertaining to a specific wild environment and on-the-go activity. Participants were asked what, where, and why questions such as, what do you use your mobile device for during the activity, where are you accessing your mobile device within the environment, and what features do you need during this on-the-go activity[9].

After questioning the sample audience, market research was conducted in order to analyze similar mobile applications that were currently available for this target audience. The applications found offered a similar set of features as to those requested by the sample audience during the questionnaire. The features of the applications were recorded, along with the organization and manner in which they were presented to the user (in relation to the interface design and navigation scheme). Through established use cases, locations of use, and user needs, scenarios were created to further guide the design process. "Scenarios are sketches with words"

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[9] Answers to these questions could include using the mobile devices for a camera, music player, GPS, or video camera, in wild environments such as muddy riverbanks, ski lifts, or sandy, for features such as location map, weather information, tide report, mileage indicator, and so on.

(Saffer 99). With the help of the scenarios, initial design decisions were made for the alternative gesture navigation scheme.

The next step was the formation of a task list. The features that would be displayed within the sample application were chosen during this phase in order to effectively display the alternative gesture navigation scheme within a realistic application. The specifications of the example application will be discussed in more detail in the *Thesis Prototype* section of this paper. The decisions within this application were made based on feedback from the target audience, along with market research and data that was collected.

Task Analysis and Gestural Vocabulary Document

Upon completion of initial observations, research, and documentation stages, the task list was analyzed to see what gestures would best match the functions being preformed. Maintaining the current idioms of interface navigation design, a *left/right, up/down* pattern was chosen. Within this, the main features are navigated in a *left to right* manner, much like that of traditional navigation bar. The subcategories are navigated in an *up to down* manner (Figure 1). Once these decisions were made, a gestural vocabulary document was formed, detailing the features that would be offered within the sample application, and the gestures needed to successfully navigate to each (Figure 2).

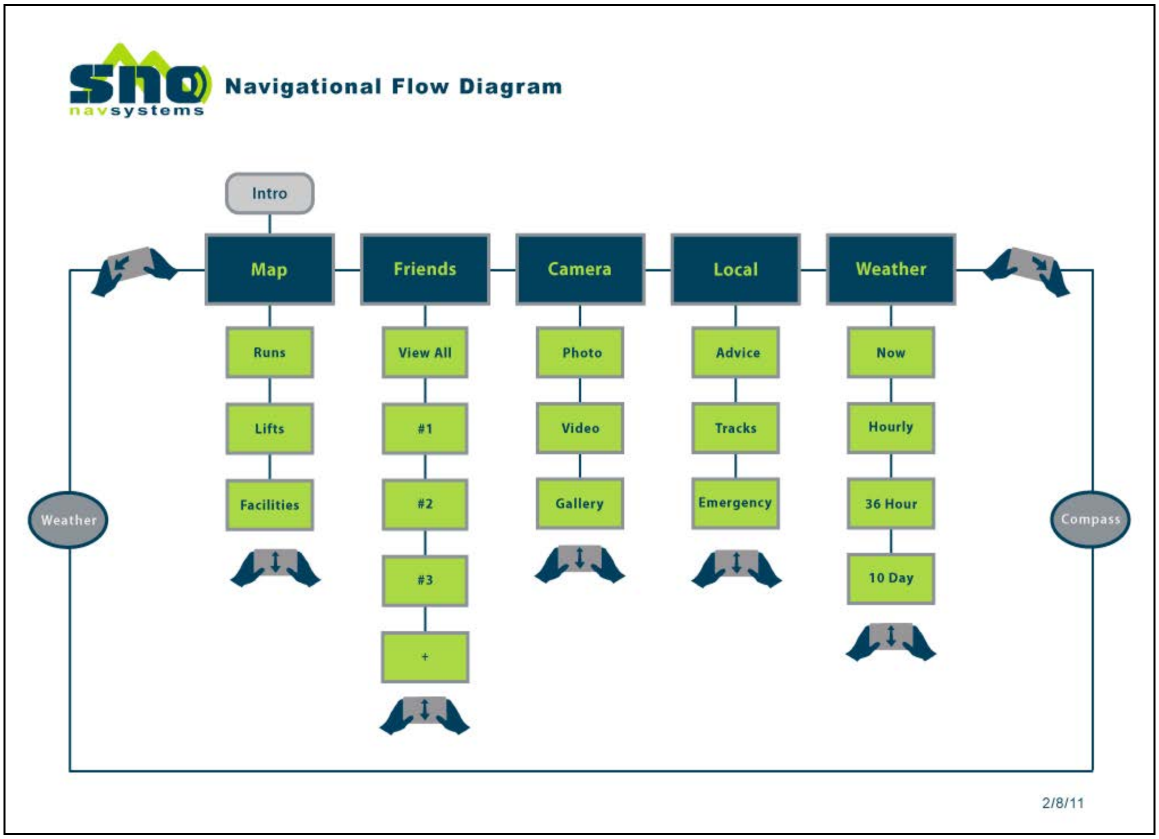

Figure 1: *Navigational Flow Diagram*

GESTURE	MODE	FUNCTION
Tilt - Left/Right (Y)	Gestural	Switch between main features
Tilt - Forward/Back (X)	Gestural	Switch between subcategories
Shake (X, Y, Z)	Gestural	Select
Orientation Change (Z)	Gestural	Switch between modes
Horizontal Swipe (Y)	Desktop (touch)	Switch between main features
Vertical Swipe (X)	Desktop (touch)	Switch between subcategories
Tap (X, Y)	Desktop (touch)	Select

Figure 2: *Gestural Vocabulary Document*

Wireframe, Prototypes, and Testing

After numerous initial sketches were completed and revised, a wireframe design was needed to detail each screen's initial design, layout, and functionality, along with the gestures required to navigate to each screen and subcategory. "Wireframes… strip down the visual and industrial design to a bare minimum so that viewers can focus their attention on the raw features, functionality, and content of a product" (Saffer 102). With the raw wireframe design, genuine and untainted feedback was gathered from testing participants regarding the navigational scheme and the gestures that were required to navigate to each feature.

At this stage, an initial *low-fidelity* prototype was developed using the paper prototyping technique. This cut down the implementation time needed to develop an initial prototype. This prototype was tested with members of the target audience to identify initial flaws and problems encountered when operating the navigational scheme. After testing the paper prototype, an HTML prototype was created. This enabled testing to be preformed on the actual mobile devices that the navigation could be fully implemented on. This prototype was followed by two digital prototypes created in Adobe Flash, and a final *high-fidelity* prototype created in XCode using Objective-C and the iPhone SDK (Figure 3).

Figure 3: *Final Prototype – Map Screen*

Members from the target audience selected for the sample application tested the Flash prototypes, and provided vital feedback that was implemented into this final *high-fidelity* digital prototype. Saffer states, "You need to test mobile products in the wild, not in the lab" (297). For this reason, members of the target audience will test the final high-fidelity digital prototype in the wild environment in which it would be used.

The final digital prototype provides a method to interact with mobile devices in wild environments, without requiring touch interaction with the mobile device screen. This proves to solve the usability issues that prior solutions fail to address. Through the software implementations discussed above, an intuitive gestural navigation system, based on well-defined user interface patterns, has been created to solve the usability issues that arise when operating a mobile device in less than ideal environments.

SOLUTION

An advanced gestural navigation scheme in mobile devices was made possible by accessing the device's accelerometer. "A popular feature in more recent mobile devices is the addition of an accelerometer, a small instrument that measures physical acceleration and gravity and sends data back to the device" (Fling 148). You often see the accelerometer used in game applications, where the user tilts the device to control an object on the screen. This input mechanism allows the device to be operated with minimal interaction with the touchscreen. The user can simply hold the phone with one or two hands and tilt the phone in numerous directions to send varying inputs to the device. This underused capability as a primary input mechanism has been added to the gestural navigation scheme created within this thesis, in order to minimize touch interaction with the mobile device screen.

Gestural Vocabulary

Dan Saffer defines a gesture as, "any physical movement that a digital system can sense and respond to without the aid of a traditional pointing device such as a mouse or stylus" (2). The gestures that have been implemented within this scheme include tilts (x and y), shakes (x, y, and z), and orientation changes (z) (Figure 4).

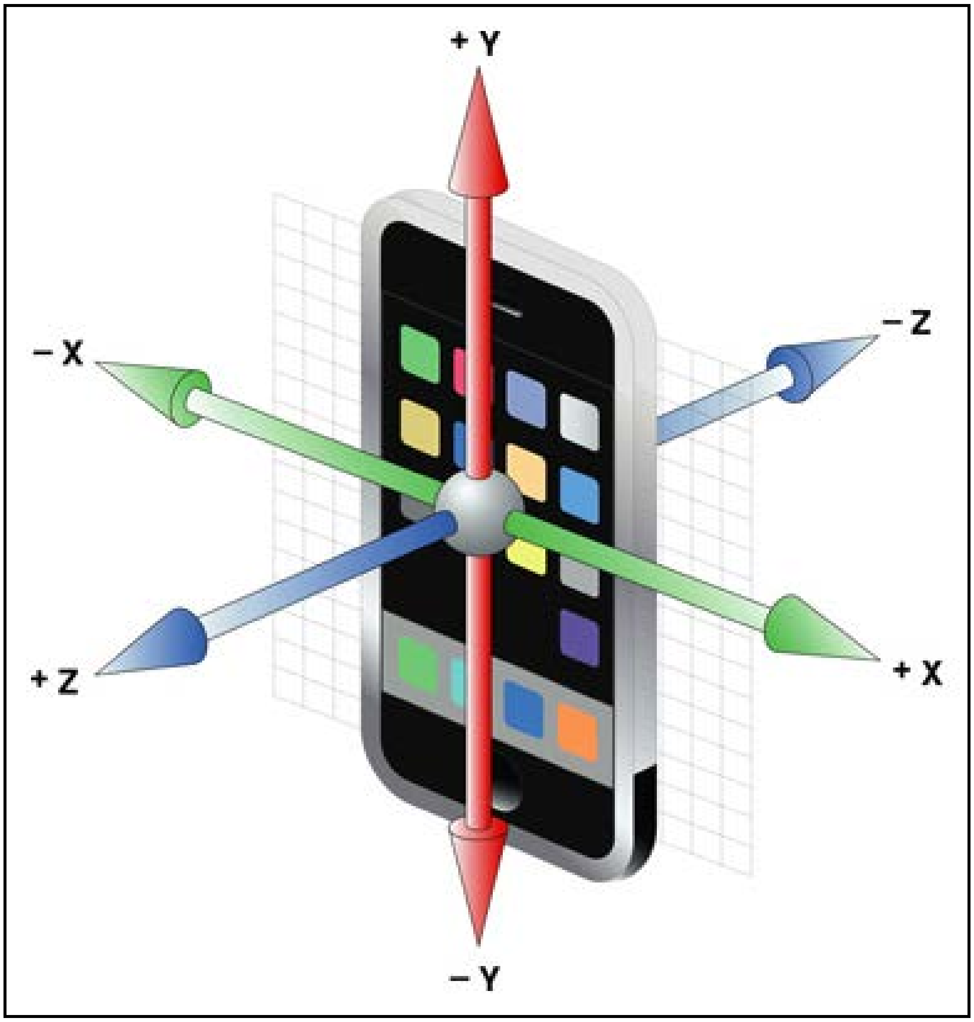

Figure 4: *Smartphone Accelerometer Diagram* (IPhone)

When held in a landscape orientation, tilting the phone left and right creates an accelerometer change in the Y-axis, and allows the user to navigate between the main features of the mobile application. Tilting the device forward and back affects the X-axis, and allows the user to navigate between the subcategories of each main feature. When the device is shaken, the X, Y, and Z values are all affected. This gesture allows the user to perform a more in-depth select input. Examples of the shake to select feature include taking a photograph or video, or selecting a friend to contact.

Orienting the phone parallel to the ground, compared to pointing it at the horizon, affects the Z-axis. When the phone is pointed towards the horizon it is in *Gestural Mode*, providing touchscreen-free navigation. When the device is laid flat it is in *Desktop Mode*, which allows traditional touch navigation for environments that facilitate this type of interaction (Figure 5). The gestures chosen for this navigation scheme have become standard interactions for mobile devices, creating a minimal learning curve for users. It is important to note that this alternative gesture navigation scheme accesses current idioms, while expanding upon them to provide an advanced gestural input system. For example, when switching into *Desktop Mode*, the user performs a slightly modified orientation change gesture. This scheme expands on the well-known orientation gesture by introducing the aspect of depth, which affects the accelerometer's Z-axis. Along with the current idioms, and innovations made within the navigation scheme, a well-known user interface pattern has been implemented to provide the user with ample and intuitive feedback.

Figure 5: *Gestural vs. Desktop Mode*

Accordion Menu System

An accordion style menu system was chosen for the user interface design of this navigational scheme, in order to provide ample feedback to the user in a manner that is easily understood. This provides a very natural feedback system, which is also very intuitive with the gestures that perform each action. Saffer recommends, "Use *Tilt to Move* as a means of controlling direction in a 3D or physical space" (88). This is what occurs in the accordion style menu. As the phone is tilted from side to side, the vertical menus slide back and forth in relation to the direction the phone was tilted.

The accordion style menu system is a well-known user interface pattern that is often used in web design. As the *User Interface Design Pattern Library* states, "Accordion menus are often used as a website's main navigation. In this way, it acts much like Navigation Tabs, as menu items are collapsed when a new panel is clicked" (Accordion). In this way, the accelerometer-based gestures have been combined with the accordion style menu system to achieve a new navigational scheme for mobile applications in wild environments. This allows the user to establish a clear mental model of the interface. As usability and human-centered design guru Donald Normal notes, "Gestural systems are no different from any other form of interaction. They need to follow the basic rules of interaction design, which means well-defined modes of expression, [and] a clear conceptual model of the way they interact with the system…" (Norman).

Color

Each tab of the accordion style menu is given a specific color in order to allude to its contained features and also to help form a higher contrast of visuals. For environments that prove difficult to read text on mobile devices, users are able to associate a specific color of each menu tab to its contained feature. This allows the user to navigate the interface based on color alone. Initially, the accordion menu tabs are colored based on a default color palette. Bergman notes, "Good default values are essential for those who do not want to customize" (193). These color settings have been established as the default values, but the user is able to customize the interface color scheme, if they choose to do so (Figure 6).

Figure 6: *Color Customization Options*

Color Customization

In order to provide the user with sufficient customization features, color customization options are provided within the navigation settings. Each user's unique view of the symbolism of color will vary, so the customization of color options for the accordion tabs is necessary (Rohrer). "Functions that allow – but do not force users to change some aspects of their device can significantly increase the subjective satisfaction with the device" (Bergman 188). By giving users the opportunity to customize the colors of their navigational menu, they can develop a higher level of usability for their interactions with the mobile device.

Augmented Reality

Augmented reality is a technology that proves beneficial to enhance the user's environment. It also fits in well with the accordion style menu system and layout of the gestural navigation and user interface design. Bolter and Gromala described this technology when they stated, "What the user sees is a combination of her physical environment and text or graphics that the computer draws… The computer lays its graphic images over the user's view of the physical world, augmenting that view" (127 - 128). Points of interested nearby the user are represented by graphics and layered overtop a live video feed displayed on the device screen.

The augmented reality graphics depict numerous points of interest for the user, with the user's position always being the angle of sight as they look through their phone at the physical environment around them. The ability of mobile devices to account for the user's current location makes this feature possible. Bergman notes, "An interesting, emerging aspect of the mobile system and application context is *location awareness:* The network and/or mobile terminal knows where the user is location geographically and can thus offer services based on the location…" (178). Thanks to location awareness, the device can pinpoint the user's current location and augment their reality to display numerous points of interest nearby. The AR graphics include a title, descriptive icon, and approximate distance from the user. The graphics are layered based on their associated distance from the user, with objects at closer distances displayed in the front of the screen, and objects at further distanced displayed in the back. This has become the standard method for depicting augmented reality graphics.

Immersive Experience

The implementation of augmented reality fits well with the gestural navigation scheme, as it encourages the user to focus their attention and hold their phone in a manner that is actively engaging them further into their current environment. This proves specifically beneficial in environments that present numerous safety concerns such as approaching hazards, falling objects, or other dangerous circumstances. By keeping the user's attention within their environment, designers can further embrace the use of mobile devices in wild environments to improve leisure activates, instead of replacing them. "Concentrating on the text or images, the user forgets about the interface (menus, icons, cursor), and the interface becomes transparent" (Bolter and Gromala 26). The augmented reality components allow the user to look through their device into the physical world with less distraction.

Desktop Mode

The navigational scheme switches to *Desktop Mode* when the phone is oriented parallel to the ground (Figure 7).

Figure 7: *Desktop Mode – For environments that facilitate touch interaction*

This mode entails a traditional touch navigation scheme for environments that facilitate this type of interaction. The user is made aware of which mode they are currently in by the differentiated color scheme of the accordion menu system. As mentioned earlier, the color schemes can be customized, but are offered with default color palettes upon the first launch of the application.

Users should not be limited to one type of interaction scheme, as the appropriate interaction method will vary depending on the environment the user is currently in. By providing both interaction methods, touch and gesture, the user can decide which interaction method is best and not be limited by the device itself.

Offering two navigation patterns has become more common as the technology has improved to allow for it. Touch and gestural patterns can be displayed within the same application. Alan Dix is quoted saying, "…the basic motive in the analysis of the context is to focus on how and when the device should behave differently and offer different interaction/presentation options depending on the context of use" (Bergman 177). By offering both interaction models, the navigation system remains dynamic and able to suit the varying wild environments in which it will be used. "If you think it best for your app to mix contexts, then give the user the option to switch between them" (Fling 81).

The user interface pattern and design remain consistent in the *Gestural* and *Desktop Mode*, with the accordion style menu present within each. The only difference is the interaction method. Instead of navigating the screens and features based on gestures, such as in the *Gestural Mode*, the screens are navigated with simple swipe gestures in the *Desktop Mode*. The user swipes left or right to dictate the movement of the accordion menu tabs, "…wiping to explore a different window" (Baumgartner and Saito 2). This natural push of the screens with the accordion menu provides a natural interaction model, with intuitive feedback to the swipe gesture and its function. This continues the minimal learning curve needed to operate the navigational scheme and provides the user with a consistent navigation pattern and user interface design.

All features available within the *Gestural Mode* can be made available in the *Desktop*

Mode, along with a few additional complexities. Since touch enables the user to enter more complex data, messaging and data entry functionalities can be implemented within the *Desktop Mode*. Examples of this include messaging a friend, viewing photo or video libraries, or posting information to a news feed. This is an appropriate mode to place the *Setting* feature of the application as well, which is where the color customization options and gesture sensitivity settings would be located (Figure 8).

Figure 8: *Final Prototype – Settings Screen*

Automated Input and Outputs

The locale-based functionality available within mobile devices allows for the navigation scheme to access automated input and outputs. Using the device's gyroscope and accelerometer, the mobile device can retain certain information about the user, such as movement, rotation, orientation, altitude, and speed (Slocum). Fling mentions this beneficial technology when he stated,

> Using the accelerometer can be a benefit to mobile users, enabling them to interact with a device in a more natural way; being that the device is likely held in the hand, it can adjust content to suit its physical orientation, like rotating the screen, or detecting physical movement, and can therefore have limited prediction of the users' context. A simple example might be that if the user is walking, detected by slight movement or velocity, the user interface might display larger text than normal to make the experience easier for users on the move. (Fling 148)

Using this data, the mobile device can predict which feature would most likely be of interest to the user, based on their current location or actions. "Unless it is turned off, your mobile device is connected to the network… this can be a huge benefit to the average user, enabling the device to predict tasks based on your location and anticipate the information you will need based on your surroundings (Fling 39). For example, if a skier is accessing a ski resort map application and they are located at a base altitude on a mountain, it would be most beneficial for the map to first visualize nearby ski lifts. This most likely would be the information the user is seeking, as they need to find a way up the mountain. If the user were located at a high altitude on the mountain, it would be most beneficial to depict nearby ski runs, as the user would most likely be seeking a way down the mountain. This type of implemented of automated inputs and outputs can cut down the amount of tasks the user must perform in order to navigate to the information they seek. This functionality would be available if the user wishes to have it active. If not, they could deactivate the automated input/output option within a settings feature of the application.

Through the implementation of accelerometer-based gestures (tilts, shakes, and orientation changes), along with an accordion style menu system, the user is able to interact with the device without touching the mobile screen. This provides numerous benefits to the user, and alleviates many of the concerns that are presented when operating a mobile device in less than ideal environments.

Thesis Prototype

The example application, *SNO Network*, created in relation to this study was developed for the target audience of ski and snowboarders in the wild environment of ski resorts. This environment is often snowy, wet, windy, and bright, and presents numerous environmental challenges often encountered in wild environments as a whole. Environmental elements, weatherproof and protective cases, bulky gear or gloves, varying lighting conditions, and safety hazards can all be found within this environment. These factors made the environment of ski resorts an ideal wild environment to research. It is also important to note that I myself am an experienced snowboarder, and found this an ideal environment to study with my knowledge of the on-the-go activities and wild environments at hand, along with my accessibility to numerous members from this target audience. In an attempt to create a new software based gestural navigation scheme for wild environments, this specific situation was selected in order to analyze the usability issues that arise when interacting with a mobile device in a specific inclement environment.

The example application depicts features such as a *Map* screen[10] (Figure 9), along with *Friends*[11] (Figure 10), *Local Advice*[12] (Figure 11), *Weather* (Figure 12), and *Camera* options (Figure 13).

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[10] The *Map* feature includes runs, lifts, terrain, and facility information.
[11] The Friends screen is used to locate other users of the application.
[12] The Local Advice feature is a news feed of recommendations submitted to the navigation website, which are fed to the user 's device based on posts that match their current location.

Figure 9*: Final Prototype for the iPhone*
Depicting the gestural navigation, which is operable while wearing bulky gear

Figure 10: *Final Prototype – Friends Screen*

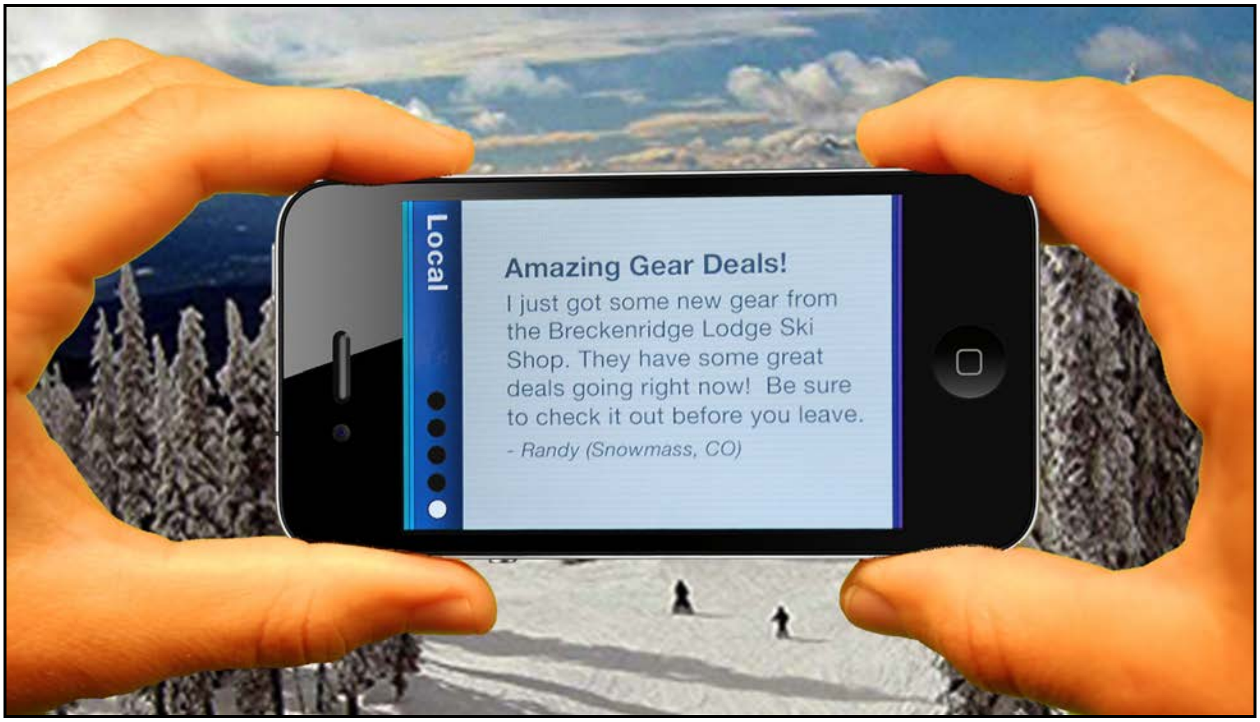

Figure 11: *Final Prototype – Local Advice Screen*

Figure 12: *Final Prototype – Weather Screen*

Figure 13: *Final Prototype – Camera Screen*

It is to be noted that the features depicted within the sample application are not fully functional, and are merely a demonstration of the features desired during this specific on-the-go activity. The creation of this sample application provided a means to implement the gestural navigation scheme in a realistic manner that could be tested by members of the target audience. This allowed for the analysis and implementation of the software solution created within this study. This navigation solves the usability issues encountered by providing touchscreen-free navigation for mobile devices in wild environments.

Additional capabilities that are demonstrated within the example application include augmented reality, locale awareness, networking, and automated inputs and outputs. These too are not fully functional, but provide an interesting insight into effective ways to design an application and user interface for the target audiences of on-the-go activities. These capabilities prove beneficial for a wide range of audiences, as they further engage the user within their current environment, provide the user with location specific information, a way to interact with friends, and streamline the navigation process. This navigation scheme could also be used for other target audiences as well. Examples of this include users on job sites or individuals caring for children. In these situations, the user is often only allotted one hand to operate their mobile device. They could be carrying equipment or tools, or tending to their children with their other hand. The one handed accessibility of this alternative gesture navigation scheme provides an interaction method that could be used when designing mobile application for these audiences, along with others, as well (Figure 14).

Figure 14: *One Handed Navigational Control*

It is my hope for this alternative gesture navigation scheme that it will be used as inspiration for future mobile application design. I also hope that it will bring attention to the usability issues that are encountered when operating mobile devices in a wild environment with a traditional touch navigation scheme. Through this study, it has been made evident that the designer does not have to be limited by the device or the environment at hand, but can provide an application that is accessible in any environment, by implemented the new alternative gesture navigation scheme that has been developed within this study. The thesis prototype has been concluded at this phase, but will hopefully be seen implemented across a wide variety of fully functional mobile applications in the future. Throughout the development of this alternative gesture navigation scheme, areas for future improvement were also noted.

FUTURE IMPROVEMENTS

"An exemplary design not only takes account of its users' needs, but also identifies new users beyond any audience originally intended (Bolter and Gromala 140). Through the development of this gestural navigation scheme, other areas of concern related to the use of mobile devices in wild environments surfaced, and presented additional challenges and opportunities that could be expanded upon related to this study. These items include the pairing of the gestural navigation scheme (software solution) to that of a hardware solution, the addition of speech input technology, and research in signal and power concerns for the use of mobile devices in wild environments.

Throughout this research study and design process, it has become evident that numerous ergonomic issues have not been addressed in relation to the use of mobile devices in wild environments. This gestural navigation scheme would prove even stronger, if it were paired with a specialized hardware solution that solved many of the ergonomic issues that arise. An example of this problem includes skiers trying to hold a mobile device with their gloves on. The way mobile devices are being designed makes it much more difficult for users to grip the phones in these types of situations, and they often find themselves dropping the devices in harsh terrain. Cases can at times alleviate this issue, but the area of ergonomics is definitely still an area that lends to future growth and innovation for the use of mobile devices in wild environments.

Another area for future expansion and innovation is the addition of speech input within this gestural navigation scheme. Bergman notes, "Another solution for hands-free operation is a speech user interface. The user gives oral commands to operate the phone and thus does not need to perform manual activities to carry out the communication task (189). The implementation of speech could be added within the *Gestural Mode* of the navigation scheme to allow the user to perform data entry type tasks (like that seen in the *Desktop Mode*). For example, the user could simply speak a message they would like to send to a friend, then say their name, and tell the device to send the message. This could all be done without touching the mobile device screen, or even performing a gestural input. This would prove very beneficial, as it would allow for the additional complexities that could be made available within the *Desktop Mode*, to be added within the *Gestural Mode* as well.

Two additional elements that have yet to be addressed for mobile applications in wild environments is signal issues and power concerns. "Unless you are in the habit of carrying around a bunch of extra batteries, expect to change your phone every hour or two as a penalty for using the modern mobile web" (Fling 157). The signal issues that are encountered in wild environments, and the related battery usage concerns, are definitely areas that still need to be addressed in relation to operating mobile devices in these types of environments. Wild environments such as on mountains, in forests, oceans, or other remote locations, often suffer from lapses in service or no service at all. This causes problems with location awareness, GPS functionalities, and other features that would often be provided in wild environment applications. As mobile technology continues to improve, along with the expansion of wireless networks, the problems with signal and battery concerns will slowly be addressed. In the meantime, power and service outages are elements of mobile design that should definitely be considered when designing for the wild.

CONCLUSION

This gestural navigation scheme for mobile devices addresses the interaction and usability issues that arise in wild environments. The scheme eliminates the need for touch interaction with the screen, allows the user to operate their device with bulky gear or gloves on, can be navigated one with hand, and allows for interaction while the device is completely sealed in a protective case. These capabilities prove very beneficial in wild environments. They allow the user a free hand to hold necessary equipment, enhance interaction with friends, reduce possibility of damaging the device, and create a much smoother and less interrupted interaction for users with their mobile devices.

Eliminating touch interaction with the screen removes the fear of damaging or smudging the sensitive touchscreen. Allowing the user to control the device with bulky gear and/or gloves on increases safety and allows the device to be used in a wider range of wild environments that necessitate this type of equipment. Since touch interaction with the screen is no longer necessary, the device can be completely sealed in a protective case and operated with gloves on. This protects the device from the environmental factors at hand, and provides ease of mind to the user that their dirty hands, gear, or environment will not damage their mobile device. One-handed use proves very beneficial also, for users in situations such as kayaking or skiing, where paddles and poles become common hindrances in the level of usability.

The gestures implemented within the navigational scheme are very intuitive to the tasks they perform. Tilting the device left slides the accordion menu left. Tilting the device forward bumps to the next option within the screen (Figure 15).

Figure 15: *Accordion Menu – Intuitive feedback to gestures preformed*

As Saffer recommends, “The complexity of the gesture should match the complexity of the task at hand” (Saffer 28). The left/right and up/down hierarchy is also a continuation of past trends, while being applied in a new manner. “One basic structuring of phone functionality is the use of *hierarchies* (or *menus*) of functions that are related…” (Bergman 185). Since the user interface pattern remains consistent throughout the application, the user is able to form a solid mental model quickly and easily. The direct manipulation of the items on screen also contributes to this, as it provides a very intuitive interface design where the user can easily learn its functionality. Tilting the phone parallel with the ground changes the navigation scheme to *Desktop Mode*, which is a very natural action, as we perform typing and touch gestures in this manner on desktop computers and tablets. The consistency of gestures proves very important as there are no confusing modes or combinations of gestures the user must perform to complete a task. By giving each gesture one function, the user does not become confused or lost by the actions each gesture performs.

The user interface design that is paired with this gestural navigation scheme provides numerous benefits to the user as well. The accordion menu system is very intuitive and provides natural feedback. The design is very simple, yet effective. "The purpose of visual consistency is to construct a believable environment for the users… Simple design is good design. Simple designs are easy to learn and to use, and they give the interface a consistent look" (Bolter and Gromala 48). By maintaining the same user interface design in the *Gesture Mode*, along with that shown in *Desktop Mode*, the pattern remains consistent and easy for the user to navigate, regardless of what interaction mode the app is in.

The features of the accordion menu system have been arranged by priority, which helps streamline the navigation process for the user. Bergman states, "In mobile usage contexts the interaction must be as efficient as possible…. This can be achieved by the following: Ordering/prioritizing menus so that the "most likely" or "most critical" functions are available first" (185). In the example application, the *Maps* and *Friends* screens are located at the beginning of the menu, as they will most likely be accessed most frequently. The *Local Advice* and *Weather* screens are located in the middle of the accordion menu. The last position of the accordion menu is also easy to settle upon, so this spot has been allotted for the *Camera* option, which would be accessed at a high degree, but not as much as the *Map* and *Friends* screens. These feature-related decisions were made based on target audience research, surveys, and questionnaire results.

The use of automated input and outputs would help streamline the navigation process for users, by predicting their needs before they even make a physical input. “It is our job to create intuitive experiences using technology to anticipate and solve problems for the user through the fewest, deliberate actions” (Fling 55). This option would allow the user to access the information they need by simply glancing at their mobile device. If the information is not what they seek, they could then perform the necessary actions to navigate to the information they desire. The menus have been kept to a small number so that the navigation process is never too daunting. In the example application, there are only five main features, with five or less subcategories within each. This allows the user to navigate the application quickly and easily.

The colored accordion menu tabs help establish a high contrast of visuals, and allow the user to associate features based on color, instead of text. The customization options allow the user to set their color palette to the feature they relate each color to. “ People respond to different colors differently… Using the right colors can be useful for delivering the right message and setting expectations” (Fling 127). By giving the user some control of the interface, they can then streamline their tasks and create a more usable and enjoyable experience with the navigational scheme. As the development of this gesture navigation scheme continued, numerous other gestural solutions were noticed popping up around the market. This brought about the realization of a gestural fad that has been implemented within a wide variety of commercial products.

Bolter and Gromala once said, "Machines that fit the human environment instead of forcing humans to enter theirs, will make using a computer as refreshing as taking a walk in the woods" (104). By accommodating the needs of mobile device users in wild environments, designers can facilitate a more enjoyable and hassle-free experience for users. In order to make this a reality, a mobile application's navigation and user interface must be designed for the environments in which it will be used. The proposed solution within this thesis keeps this at the highest priority. For wild environments, a gestural navigation scheme, along with an accordion-style visual feedback system, allows for the user to operate the mobile application in the most appropriate way, while providing the information the user needs in a natural and intuitive manner.

As the Nielsen Company states, "The key to unlocking Mobile is to take advantage of its unique anytime/anywhere enablement of information exchange" (Stewart and Quick). By creating a gestural navigation scheme for mobile devices, users can now access application features in wild environments, without suffering through the usability issues that were once commonplace within these situations. This solution removes the major issue of touch interaction with the screen, unlike past attempts at resolving this problem, and therefore allows the user to truly take advantage of mobile's anytime/anywhere capabilities. Throughout the history of interaction design, we have designed "new ways of interacting with our devices, environment, and each other" (Saffer 4). With this solution, application designers are now able to more effectively design mobile applications for the wild.

Appendices

Appendix A.

Target Audience and Market Research

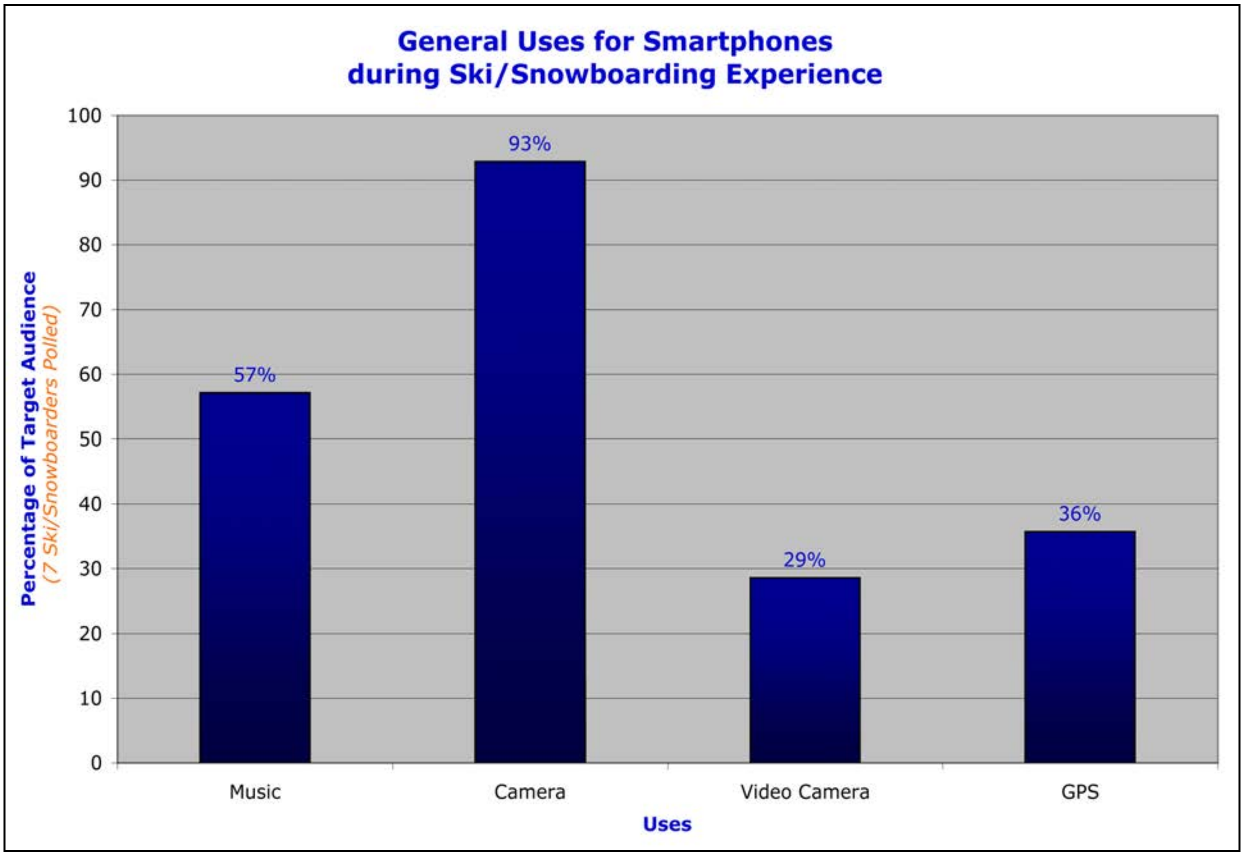

Figure 1: *General Uses for the Device*
During the specific on-the-go activity of ski and snowboarding

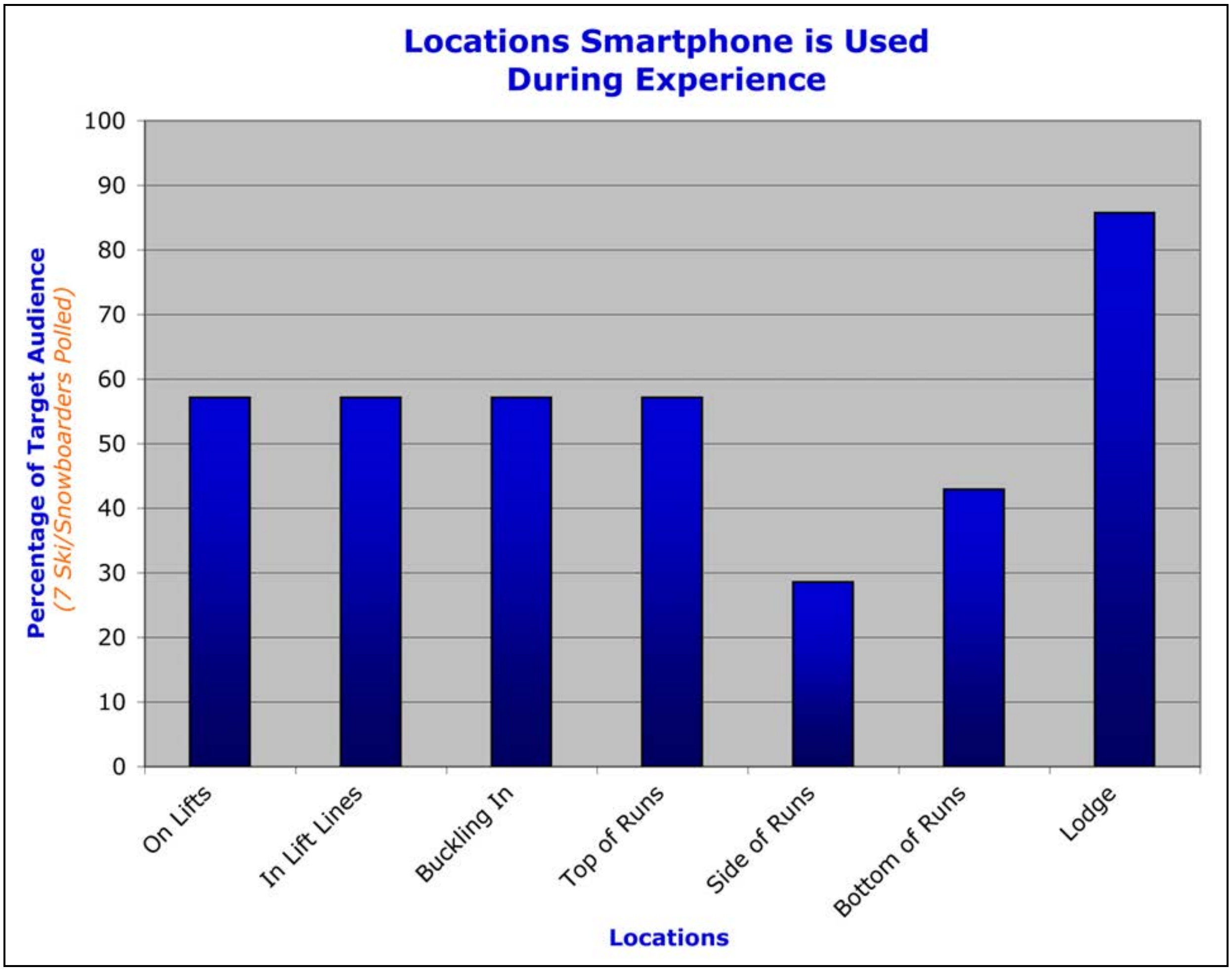

Figure 2: *Locations of Use*
Within the environment of ski resorts

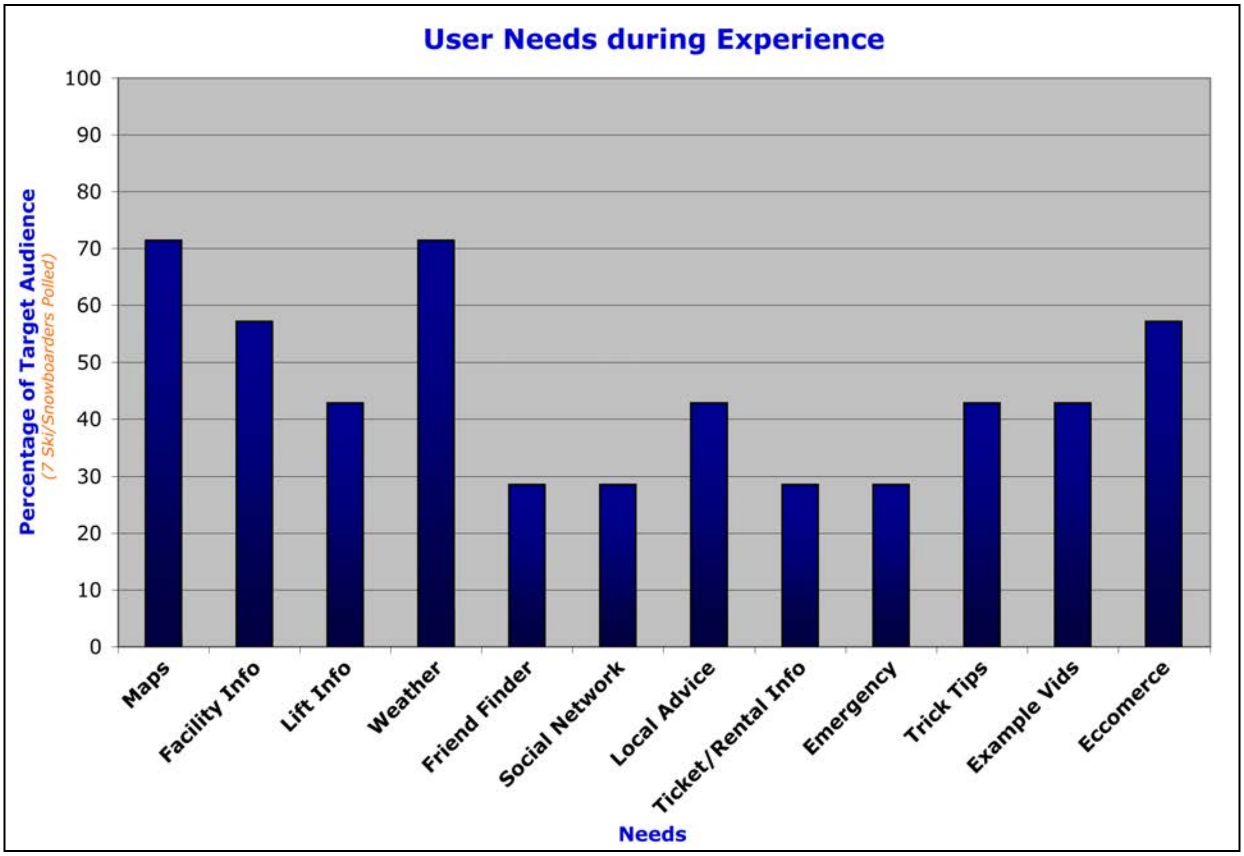

Figure 3: *User Needs*
During the on-the-go activity of ski and snowboarding

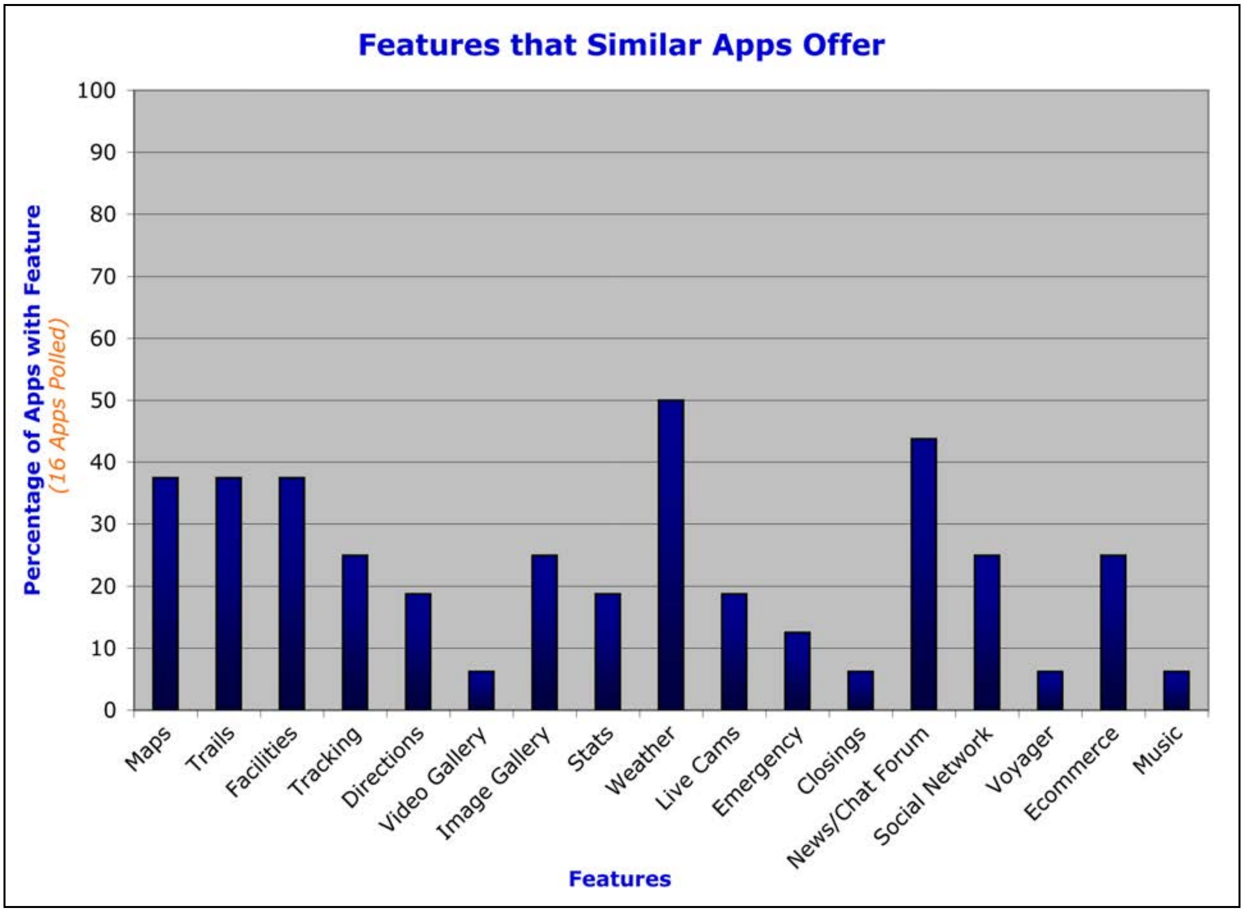

Figure 4: *Market Research – Apps for similar target audiences to that of ski and snowboarders*

Appendix B.
Prototypes

Figure 5: *Paper Prototype*

Figure 6: *User Testing of Paper Prototype*

Figure 7: *Flash Prototype I*

Figure 8: *Flash Prototype II*

Figure 9: *Final Prototype – Designing for the Wild*

Bibliography

"Accordion Menu." *UI Patterns - User Interface Design Pattern Library*. UI-Patterns.com. Web. 04 May 2011. <http://ui-patterns.com/patterns/AccordionMenu>.

"Aquapac Waterproof Case for IPhone and Droid." *Amazon.com: Online Shopping for Electronics, Apparel, Computers, Books, DVDs & More*. Amazon.com. Web. 26 Apr. 2011. <http://www.amazon.com/Aquapac-Waterproof-Case-iPhone-Droid/dp/B001G5A4JA>.

Baumgartner, Garrett, and Shiori Saito. *Web/Literature Survey of Touch_Based Hardware and Research*. June 2010. Web. 01 May 2011. CIRO Project. Alberta College Of Art + Design. <http://www.cirolab.org/blog/wp-content/uploads/2010/07/Web_and_Literature_Survey_CIRO_Project.pdf>.

Bellis, Mary. "Who Invented the Computer Mouse - Douglas Engelbart." *Inventors*. About.com. Web. 25 May 2011. <http://inventors.about.com/library/weekly/aa081898.htm>.

Bergman, Eric. "Information Appliances and Beyond - Interaction Design for Consumer Products." San Diego: Academic, 2000. Print.

Bolter, J. David, and Diane Gromala. "Windows and Mirrors: Interaction Design, Digital Art, and the Myth of Transparency." Cambridge, MA: MIT, 2003. Print.

Buchanan, Ricky. "Tilt, Turn, Shake – IPhone Games Using Alternate Inputs." *ATMac:*

Empowering Disabled Apple Users. ATMac, 12 Sept. 2008. Web. 04 May 2011. <http://atmac.org/tilt-turn-shake-iphone-games-using-alternate-inputs>.

Buxton, William. “Sketching User Experiences: Getting the Design Right and the Right Design.” Amsterdam: Elsevier/Morgan Kaufmann, 2007. Print.

"Find Your Perfect Case." *We've Got Technology Covered*. OtterBox.com. Web. 26 Apr. 2011. <http://www.otterbox.com>.

Fling, Brian. “Mobile Design and Development.” Beijing: O'Reilly, 2009. Print.

"FREEHANDS Tech-Tip Gloves" *Gloves Online: GO Gloves, Your Source for Gloves since 1996*. Gloves Online. Web. 26 Apr. 2011. <http://www.gloves-online.com/proddetail.php?prod=FH-1120B>.

"FREEHANDS Men's Soft Shell Gloves." *GO Gloves, Your Source for Gloves since 1996*. Gloves Online. Web. 26 Apr. 2011. <http://www.gloves-online.com/proddetail.php?prod=FH-1121>.

Ganapati, Priya. "Rugged Cellphones Make IPhones Look Like Wimps." *Wired.com - Gadget Lab*. Wired.com, 14 July 2009. Web. 26 Apr. 2011. <http://www.wired.com/gadgetlab/2009/07/rugged-cellphones/>.

Gilbert, Ben. "Kinect-controlled Netflix Available Today on Xbox 360." *Joystiq*. AOL Tech, 14 Apr. 2011. Web. 16 May 2011. <http://www.joystiq.com/2011/04/14/kinect-controlled-netflix-available-today-on-xbox-360/>.

"Google April Fools' Day 2011." *Google Operating System (Unofficial Google Blog)*. Web. 16 May 2011. <http://googlesystem.blogspot.com/2011/04/google-april-fools-day-2011.html>.

Hannaford, Kat. "An Outdoorsy Phone Running Android: Motorola Defy." *Gizmodo, the Gadget Guide*. Gizmodo, 1 Sept. 2010. Web. 26 Apr. 2011. <http://gizmodo.com/#!5627164/an-outdoorsy-phone-running-android-motorola-defy >.

"History of Elo." *Company History from Elographics to Elo TouchSystems*. Ed. Debi Brown, Cheryl Steinbacher, Tonya Turpin, Rhonda Butler, and Chuck Bales. Elo TouchSystems. Web. 04 May 2011. <http://www.elotouch.com/AboutElo/History/default.asp>.

"IBM Simon." *Wikipedia, the Free Encyclopedia*. Wikipedia. Web. 04 May 2011. <http://en.wikipedia.org/wiki/IBM_Simon>.

"IPod Nano: About Shake." *Apple - Support*. Apple, 9 Sept. 2010. Web. 04 May 2011. <http://support.apple.com/kb/ht2907>.

"IPhone Tutorial - Reading the Accelerometer | Switch on the Code." *Switch on the Code*. SwitchontheCode.com. Web. 04 May 2011.

<http://www.switchonthecode.com/tutorials/iphone-tutorial-reading-the-accelerometer>.

Kelly, Kevin. "Minority Report UI Designer John Underkoffler Talks about the Future of Gestures." *Joystiq*. AOL Tech, 7 May 2010. Web. 05 May 2011. <http://www.joystiq.com/2010/05/07/minority-report-ui-designer-john-underkoffler-talks-about-the-fu/>.

Krakowsky, Tali. *A VERY, VERY BRIEF HISTORY OF GESTURAL INTERFACES*. The Best in Advertising, Design, and Digital Creativity - AdCritic. Creativity Online, 27 Oct. 2009. Web. 16 Apr. 2011. <http://creativity-online.com/news/a-very-very-brief-history-of-gestural-interfaces/139976>.

Lifeofthetouchcreen. *Life of the Touch Screen Timeline | Timetoast Timelines*. Timetoast.com. Timetoast. Web. 16 Apr. 2011. <http://www.timetoast.com/timelines/56311>.

Morisy, Michael. "Rugged Mobile Devices Must Be More than Durable in Harsh Environments." *Mobile Computing Information, News and Tips - SearchMobileComputing.com*. SearchMobileComputing.com, 13 Aug. 2008. Web. 26 Apr. 2011. <http://searchmobilecomputing.techtarget.com/news/1325123/Rugged-mobile-devices-must-be-more-than-durable-in-harsh-environments>.

NielsenWire. "U.S. Smartphone Market: Who's the Most Wanted?" *Nielsen Wire*. The Nielsen Company, 26 Apr. 2011. Web. 25 May 2011.

<http://blog.nielsen.com/nielsenwire/online_mobile/u-s-smartphone-market-whos-the-most-wanted/>.

Nimoy, Josh. "1969 - VIDEOPLACE by Artist, Myron Krueger." *History - VIDEOPLACE by Myron Krueger*. Web. 25 May 2011. <http://jtnimoy.net/itp/newmediahistory/videoplace/>.

Norman, Donald A. "Natural User Interfaces Are Not Natural." *Interactions* May + June 2010: 6-10. Volume 17 Issue 3. *ACM New York, NY, USA*. Print.

"One-tap Wonders." *IPod Nano - Music with Multi-Touch, FM Radio, and More*. Apple. n.a. Web. 04 May 2011. <http://www.apple.com/ipodnano/features.html>.

O'ReillyMedia. "Dan Saffer - O'Reilly Media." *O'Reilly Media - Technology Books, Tech Conferences, IT Courses, News*. O'Reilly Answers. Web. 24 May 2011. <http://www.oreillynet.com/pub/au/3423>.

Rohrer, Ken. "Color Symbolism And Culture." *Symbolism of Color: Using Color for Meaning*. The Incredible Art Department. n.a. Web. 05 May 2011. <http://www.princetonol.com/groups/iad/lessons/middle/color2.htm>.

Saffer, Dan. "Designing Gestural Interfaces." Sebastopol, CA: O'Reilly Media, 2008. Print.

Siddharth. "10 Best Features of IPhone." *Tech4World — The Ultimate Tech Zone*. Tech4World, 19 Sept. 2010. Web. 04 May 2011. <http://tech4world.net/10-best-features-of-iphone.html>

"Sketchpad." *Wikipedia, the Free Encyclopedia*. Wikipedia. Web. 04 May 2011. <http://en.wikipedia.org/wiki/Sketchpad>.

Sutherland, Ivan Edward. *Sketchpad: A Man-machine Graphical Communication System*. Tech. no. 574. Cambridge: University of Cambridge, 2003. Print.

Slocum, Mac. "Mobile Accelerometers and Gyroscopes Explained." *O'Reilly Answers - Clever Hacks, Creative Ideas, Innovative Solutions. Ask, Answer, Share*. O'Reilly Answers, 15 July 2010. Web. 05 May 2011. <http://answers.oreilly.com/topic/1751-mobile-accelerometers-and-gyroscopes-explained/>.

Stewart, Jon, and Chris Quick. *Europas Fuhrender Mobile Technology Und Media Anbieter*. Rep. The Neilsen Company, 15 Sept. 2009. Web. 16 May 2011. <http://group.yoc.com/articles/01100/NIELSEN_20090915_To_Mobile_or_Not_to_Mobile__Digital_Strategies_for_Advertisers.pdf>.

Wardrip-Fruin, Noah, and Nick Montfort, eds. *The New Media Reader*. Cambridge, MA: MIT, 2003. Print.