Usability Evaluation of a Commercial Pocket PC Phone: A Pilot Study

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ABSTRACT
Advanced mobile phones, such as Smartphones and Pocket PC phones, can potentially provide cost-effective ubiquitous IT access. Towards evaluating their potential and discovering their usability problems, we distributed state-of-the-art Pocket PC phones to 10 mobile users and employed a triangulation of research methods to study their usage for two months. Our research methods included qualitative inquiries in the form of focus groups and structured interviews, and quantitative measurements in the form of *in-situ* logging. Unlike most previous studies that focused on a single design aspect, our study provides a comprehensive picture regarding the holistic usability of advanced mobile phones.

Keywords
Mobile phones, human-computer interaction, Smartphones, usability.

1. INTRODUCTION
ITU estimated that 28% of the world population had mobile phones in 2004. while only 13% used personal computers (PCs) and 13% had access Internet access [2]. On the other hand, technological progress has equipped advanced mobile phones, such as Smartphones and Pocket PC phones, with powerful processors, massive storage, and high-speed data services through Wi-Fi and cellular networks. Such phones provide a compelling alternative to PC-based initiatives for under-served populations to access IT, such as the one-laptop-per-child project [3].

However, no systematic studies have been reported for the usability of advanced mobile phones; existing work often focus on a single aspect of mobile phone design, such as the user interface. We believe that mobile phone design is essentially about tradeoffs between different design aspects, and the usability must be evaluated in a *holistic* fashion, i.e., through study of long-term usage under realistic settings and addressing a comprehensive set of usability issues.

In this study, we employed a triangulation of research methods to evaluate the holistic usability of a commercial Pocket PC phone. We distributed 10 commercial Pocket PC phones of the same making to 10 participants and studied their usage for two months, as a pilot study for a larger scale deployment. To gather quantitative information on real-world connectivity and usage patterns, we developed and installed software to automatically log network availability and battery charge levels. We then conducted focus group discussion sessions and interviews to obtain our participants' subjective opinions and collect their stories with the phones.

To the best of our knowledge, our work is the first public study to address the holistic usability of advanced phones through long-term field trials. We found that while advanced mobile phones may provide a plethora of applications, they must be easy to access and battery efficient to gain user acceptance. Further, we found that while advanced mobile phones can be a feasible platform for IT access, they are not for everyone. Finally, we present a number of important findings regarding the design and flaws of the advanced phones in general and the phone used in this study in particular. This study not only enabled us to evaluate the usability of the advanced mobile phones, but helped us refine our research methods for a future larger scale deployment in an under-served population.

In the rest of the paper, we first present our research methods in Section 2. We then present our findings in Section 3, and address the limitations of our study and discuss related work in Section 4.

2. RESEARCH METHODS
We employed a popular state-of-the-art commercial Pocket PC phone, the HTC Wizard, in our user study (Figure 1). The Wizard is one of the first GSM Pocket PC phones in the US market with Wi-Fi. It has been commercially available under a variety of brands [1]. It has a 2.8″ LCD with touchscreen and a sliding QWERTY keyboard. It measures as 109 x 58 x 24 mm and is loaded with numerous applications, like typical Windows Mobile 5 Pocket PC phones.

Figure 1. The HTC Wizard and its sliding keyboard

2.1 Participants
For this study, we recruited 10 mobile phone users aged between 20 and 26 from engineering students of Rice University. There were four main reasons for our choice of them for this pilot study. First, they are more accessible and we can easily provide them with technical assistance. Second, they better understand the privacy concern of the study and trust the investigators to an extent. Third, they have a decent understanding of the technol-

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ogies involved in the usability study. Fourth, they all have Wi-Fi access on campus, and some of them also have Wi-Fi at home.

Our participants had been mobile phone users for at least a year, and had little prior experience with the Wizard. They used our phones as their primary mobile phones with their own SIM card for two months. Upon giving the phone to each participant, we provided them with a brief introduction to the phone operation and features. We also offered to help them to set up their email account whenever they preferred. We provided all participants with links to an electronic version of the user manual and software to enable them to synchronize the phone with their PC.

2.2 Methods

Focus Group Discussion and Interviews

We conducted four focus group discussion sessions with the participants after one and two months of phone usage, each with five of the participants. In the focus groups, many topics were discussed, regarding the phone features, user interface, ergonomics, battery life, etc. The focus group discussions were recorded and later manually transcribed, coded, and analyzed. After the focus groups, we interviewed some participants regarding the interesting comments they made during the focus groups.

In Situ Logging

To quantitatively assess usage and network availability of our participants during real-life usage, we developed a non-intrusive *in situ* logging software. The software records the battery charge level and the signal strength and IDs of available cell towers and Wi-Fi access points every minute. It also reduces the standby battery lifetime from about five days to about two days. Nevertheless, our participants were informed that the standby battery lifetime was about two days before participation. We assumed that they would simply view it as a phone with a two-day standby battery lifetime.

3. FINDINGS

We next present our findings from the user study. We will first present findings considered general to most advanced phones, and then discuss the design flaws in our particular phone, the Wizard.

3.1 Advanced Phones Are Not For All

Mobile phones are well-known for their diversity in physical attributes, hardware, and software, to suite users with different tastes and requirements. Therefore, it is not surprising that our participants had different feelings towards these phones.

Size and Weight Matter

Advanced touchscreen phones are typically larger and heavier than normal phones. The Wizard is no exception, especially due to its sliding keyboard. The large size was unanimously mentioned by our participants as being inconvenient. To facilitate the carrying of the phone, we provided each participant with a fitted commercial holder, which could be attached to their belt or pants. However, only three participants used the carry case. The other seven kept the phone in their pockets, mostly stating the holder as inconvenient or uncomfortable.

Our participants were divided on whether they are willing to give up compactness for added capabilities. For participants who used their phones solely for voice communication there was no motivation to accept this tradeoff. For example:

> *This phone is larger than my previous phone, and I hate it for that, as I only use the phone for voice calls.*

> *This phone is huge, and won't fit my pocket… I don't need any applications, no web, no media player, no nothing, and I use is only as a phone.*

The large screen and rich features of the Wizard creates a positive social significance. Mobile phones are known to be social symbols and fashion accessories [11]. Some of our participants mentioned, and most others agreed, that the larger but fancier Wizard scores well in this regard. For example:

> *The phone is different from my own phone… [in that] it impresses people. I get compliments on my phone.*

Ready Access to PCs Limits Advanced Phone Usage

Most of our participants had access to Internet-connected PCs throughout the day. Therefore, they used the advanced features of the phone only as supplements to PCs. However, they unanimously agreed that they would have liked or benefitted from its extra features have they not had regular access to PCs, or were moving around. Therefore, we expect that advanced phones to be more valuable to people without convenient access to IT.

3.2 Conceptual Dilemma

We found that advanced mobile phones like the Wizard are in an awkward conceptual dilemma between PCs and simple mobile phones. For any given feature, our participants expected the Wizard to function in a way similar to either PCs or simpler mobile phones, based on their assumption. Inconsistency between the Wizard and the assumed device, PC or simpler phone, can lead to dissatisfaction. We present some examples.

Phone Expectations

When using standard phone features, such as voice communication, SMS, and camera, our participants expected the Wizard to provide an experience similar to simpler, less powerful phones. Unfortunately, even though the Wizard is considerably more powerful than standard phones, many participants complained about its responsiveness. For example:

> *[On] any cheap phone you can click and it immediately reacts, this phone is so powerful, but so slow.*

> *My old phone was faster. I have to wait a lot to open up the camera application, and even to quit it [on the Wizard].*

Our participants also expected to be able to operate the Wizard single handedly for standard phone features. Even though the hardware keyboard greatly facilitated text messaging, some participants complained single handed operation is impossible on the touchscreen or the sliding keyboard. For example:

> *It is not convenient for single handed use, especially when I'm driving. With my previous phone, I could easily send text messages, or find somebody [in the address book].*

PC Expectations

On the other hand, users expect an experience similar to PCs when using advanced features, such as email, web browsing, and multitasking. Some of these inconsistencies are due to the poor design of Windows Mobile. One example is the X button on the upper right corner of application windows, as seen in Figure 3(a). Our participants assumed that clicking it would close the application, as on Windows PCs. But it only minimizes the window, and the application remains in memory so that it can be re-launched quickly. This confused our participants, and increased resource usage on the phone, possibly leading to more crashes. A few participants had eventually found the function to actually

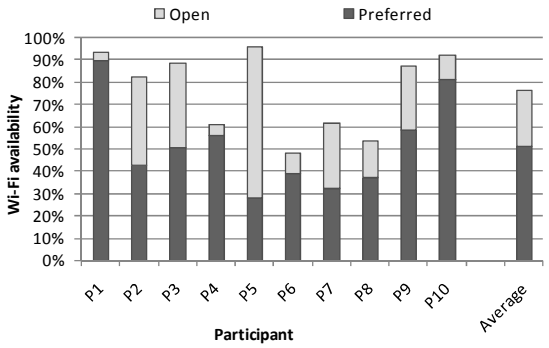

Figure 2. Wi-Fi availability throughout the daily lives of our participants

(a) (b) (c)

Figure 3. Complicated process for a Wi-Fi connection: (a) turn on the Wi-Fi interface manually, (b) choose the desired network, (c) specifying the type of network.

close an application, but complained that it is deep inside the phone settings.

Another example is the security concerns of some participants, covered in detail in Section 3.3. They expected the phone to have antivirus and firewall software similar to PCs, and were hesitant to browse the Web on the phone, concerned with viruses and Trojans.

3.3 Internet Connectivity

The Wizard has built-in Wi-Fi, making it a promising device to provide a high-performance wireless experience. Using the *in situ* logged traces, we found that on average, accessible Wi-Fi was available during more than 50% of our participants' lives. All of our participants had Wi-Fi access on campus. Some of them also had Wi-Fi at home. Figure 2 shows Wi-Fi availability for through each participant's daily life. *Preferred* networks are those the user is known to have access to, e.g., campus and home Wi-Fi. *Open* includes networks that are not encrypted. On average, our participants were covered by preferred and open Wi-Fi networks for 52% and 77% of their daily lives, respectively. While not all *open* Wi-Fi are accessible, Nicolson *et al.* showed 46% of all unencrypted access points in residential areas were accessible [9].

Only five participants actively used the Internet connectivity on the Wizard. Our study has identified several factors that impacted their usage.

Security and Privacy Concerns of Internet Access

Our study highlights the importance of educating users to the risks associated with internet connectivity, and how to avoid them. Three participants told us they were hesitant to connect to the internet in fear of Trojans and viruses that may jeopardize private information, although Trojans and virus are not yet very common for phones. For example:

> *I currently don't have a laptop, but I'm hesitant to use it [internet on the phone], because of Trojans and viruses. It's not like a computer that I can clean it [if it becomes infected]; it is my only phone line. And I have personal stuff on it. It's dangerous.*

Wi-Fi Connectivity Experience Not Smooth

Having Wi-Fi enabled consumes considerable power, to the extent that the phone will become noticeably warm. This was noticed by some participants. Our measurements show that when the Wi-Fi is enabled, even in the maximum battery saving mode, the battery life of an otherwise idle phone is reduced from about five days to less than 14 hours. Therefore, Wi-Fi should be enabled only when required, and turned off afterwards. Manually enabling Wi-Fi and the chore of setting up a connection for the first time complicates the connectivity experience. Figure 3 shows the necessary but complicated process for a user to establish a Wi-Fi connection on the Wizard. While the connection setup is less challenging to our participants with rich IT knowledge, it can be difficult to people without adequate IT training.

3.4 Every Step Matters

We found that every single step in accessing a feature greatly impacts user satisfaction.

Sliding QWERTY Keyboard

The integrated hardware keyboard provides a very convenient method for text entry. However, some did not use it because of the extra step of "rotating the phone and opening the keyboard".

Finger Instead of Stylus Used for Touchscreen

Many of our participants disliked using the stylus because the extra steps of taking the stylus out and placing it back in made it "hard to use" and "inconvenient".

Single-Step Operations Welcomed

Participants found that single-step operations are extremely convenient. One such example was that the touchscreen on the Wizard allows them to lock the keypad/touchscreen by a single tap, especially with a finger, while most mobile phones require at least two steps. Another example was the single-tap speakerphone capability. Indeed, software definable buttons on the touchscreen enables each application to provide single-tap access to frequently used functions. All participants indicated they liked such single-step operations.

3.5 Hot Applications are Simple

We found that the most frequently used applications, beyond standard phone features (voice communication, SMS, and camera), are simple, easy to access and battery-efficient.

Personal information management (PIM) software is the most used non-voice application by our participants, as phones are considered personal (not shared) and are always with their users. All but one of our participants used and liked the calendar. They mentioned that its capability to synchronize with computers made the calendar easy, obviating text entry. Nevertheless, many participants had also used the phone for their task lists or shopping lists. The only participant who did not use the calendar told us that it was because he was almost always beside his laptop.

Three participants used the phone for playing music (with Medial Player). However, one of them complained that Media Player introduced crashes. One participant regularly used Wi-Fi connectivity to watch streaming video on the phone. He told us

that he was very happy with the large LCD screen for watching videos, but was unhappy with the battery life being reduced to "an hour or so".

None of our participants used the pre-installed productivity software, such as Excel and PDF reader, while such software has been a selling point for advanced mobile phones and may contribute considerably to the overall cost of the Wizard.

Better UIs Promote New Applications

We found that user interfaces have a large impact on what features participants use. For example, the integrated QWERTY keyboard promotes text messaging. Participants who regularly entered text liked it. Its convenience actually *introduced* two participants to text messaging. One of them told us:

> *I never texted before this phone. I started texting because of the keyboard on this phone.*

Another example is the large LCD, liked by most participants. Two commented they started to watch streaming video and play games, respectively, because of the large LCD.

3.6 Design Problems Specific to the Wizard

Lack of Auto Key Lock

The large touchscreen requires the users to religiously lock the keypad/touchscreen before storing the phone, e.g., in the pocket. Auto-lock functionality could have helped a lot, but the phone did not have it. Our participants complained about "their pockets calling their contacts". However, after a few such incidents, they all managed to manually lock the phone after each use.

Inadequate Battery Indicator

The battery indicator on the Wizard used in our study provided minimal feedback, as they only had two bars (Figure 4). In the focus groups, all participants stated their dissatisfaction with the indicator feedback. The inadequacy in the battery indicator prevented them to enjoy a longer battery lifetime. As revealed by the logged battery charge level traces, our participants had significant battery remaining upon recharge, 44% on average. Five participants recharged their phones based on the indicator, and, on average, they had 50% battery remained upon recharge.

Figure 4. The 2-bar battery indicator on the Wizard

Furthermore, there is no way to find out the charge level when the phone is being charged. Some participants mentioned that they had to disconnect the charger to tell the battery level.

System Stability

Our participants noticed that the Wizard crashed more often than their own, less powerful phones. Crashes varied considerably between different users, depending on what programs they used. However, the crash recovery experience could have been better. For example, the phone sometimes requires manually resetting the system time and date after a crash. Most of our participants had expected it to be able to automatically retrieve the time through the cellular network.

4. DISCUSSION AND RELATED WORK

Our study is first limited in our participants. All are young engineering students with abundant access to computers and Internet. However, they provided a valuable window into the usability of such phones. We are currently leveraging this experience for a larger scale usability study with an under-served population. Our study is also limited in using only a specific phone, the HTC Wizard, while mobile phones are well-known for their diversity. Nevertheless, much of our study focuses on the generic design aspects common to many advanced mobile phones. Our findings will be valuable for the design and optimization of advanced mobile phones.

4.1 Related Work

Human factors in mobile computing system design have been the subject of intensive research in recent years. Kjeldskov and Graham provided an excellent survey in [6]. However, existing work often address a specific aspect of mobile phone design, e.g., user interfaces such as input methods [12], a specific application such as mobile video[8, 13], social significance [11], availability [10]. Yet, other work view the phone as a specialized tool [4, 5]. In contrast, our study is *holistic*, including user interfaces, system, hardware, and applications. Kurniawan studied mobile phone usage by older women [7]. She employed focus group discussion and online questionnaires to understand how the targeted population receives different aspects of their own mobile phones with a focus on form factors. On the contrary, our approach was to give all participants the same phone and study their usage over a relatively long time. Therefore, we have been able to identify usability problems in real usage, and study how participants receive similar features in a controlled fashion.

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