Designing Usable Applications for Mobile Computing

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Abstract: Current and upcoming WAP-enabled mobile phones introduce new user interfaces for which standard application design methods often fail. The translation of HTML to WML or XML, produce screen layouts and input methods that are often unusable on mobile phones. In this paper we suggest some guidelines for designing WAP applications and in particular, for the development of the user interface. Firstly, we give a brief summary of the unique features of phone interfaces and the technologies used to build WAP applications. We then provide guidelines on how to develop usable applications for WAP devices. Finally, we introduce the Wireless Entertainment Guide (WEG) prototype that is based on the Local Entertainment Guide (LEG) web site to demonstrate the design issues discussed.

Keywords: Mobile computing, user interface design, mobile interaction

1. INTRODUCTION

Recent years have seen the introduction of many types of computers and devices (e.g. cellphones, PDA’s, etc.) and the availability of such a wide range of devices has become a challenge for designers of interactive software systems [11]. Users now wish to be able to seamlessly access information regardless of the device they are using. Wireless Application Protocol (WAP) phones are a growing part of the mobile market in South Africa. Usability is a crucial requirement for this kind of service, which must be easily operated by users on small screens and keyboards [6]. Designing for mobile devices is fundamentally different from designing for the web [12]. Not only are there differences in the technology, but also in the way in which people use the services. These differences must be taken into account when designing the user interfaces for mobile devices. In order to afford real value to the users, designers must focus on the quality of mobile user interfaces, as well as satisfying the needs of the users. This paper discusses several guidelines on how to develop usable applications for WAP applications that are based on empirical research into WAP usability [6], [12].

One of the reasons that many WAP sites have failed is that many simply tried to carry their web sites over to the mobile Internet [13]. Understanding the fundamental differences between mobile and the web is essential for the success of mobile applications. This implies matching user goals to the specific context in which people use mobile devices. One of the key issues of context of use relates to the content that is provided. Offering the same content through multiple channels is not the right approach if an acceptable user experience cannot be provided. Services need to be optimised for the targeted device. This paper discusses the development of a WAP site called the Wireless Entertainment Guide (WEG) that was created to provide selected information from the Local Entertainment Guide (LEG) web site using a user-centred design approach.

2. MOBILE COMPUTING INTERFACES

The CEO of the WAP Forum, Scott Goldman, maintains that by 2004 more people will access the Internet from wireless devices than from PCs [2]. By the end of 2002, every phone from every manufacturer is expected to come standard with a WAP browser. Wireless phone users purchase new phones approximately every 14 to 18 months, implying that in a few years every mobile phone will have a WAP browser. Just as Netscape and Internet Explorer evolved from their first iterations, so are WAP browsers. Future WAP browsers will have to be designed to meet the challenges of, and to capitalize on, the unique characteristics of mobile devices.

WAP devices have a variety of interfaces; output can be presented as text, formatted text, or graphics. Input is provided by touch screens and/or buttons. Displays are in general much smaller than those of PCs, however the size varies significantly. The Ericsson MC218, for example, has a 640x240 pixel display, whereas the Nokia 7110 has only 66x65 pixels; a ratio of about 24:1. In contrast, workstation screens differ by a ratio of only 6:1 (1600x1200 compared to 640x480). The large disparity between screen sizes makes it almost impossible to design an application so that it fits all WAP devices [4].

The input mechanisms provided by WAP devices are also inconsistent. PDA-like devices offer point and click or a touch screen while most phones rely on a set of buttons. However, link navigation with a button interface is more difficult than with point and click. Scrolling up and down is supported very well on most devices (e.g. Navi-Roller on Nokia 7110), whereas the display width is often fixed and no horizontal scrolling is possible. Text input is difficult and time consuming on most phone-sized devices. These devices are better suited to, and users are more accustomed to, entering numbers. PDA-like devices, on the other hand, typically come with alphanumeric keyboards.

3. WAP APPLICATIONS

The wireless web is not expected to replace desktop web access [2]. Mobile users have very different needs from their desktop counterparts. The mobile user requires rapid access to specific information. Mobile services must target users with immediate, context-directed content [13]. The key application areas are expected to be Sports, Entertainment, News, Weather and Travel [12]. In the absence of an agreed
It is important to identify the benefits of bringing an application to the WAP platform. A potential benefit, for example, is universal access to information that is vital while on the move (e.g. contact addresses, travel information). If information is already provided on a web site and should also be available on WAP, very precise task analysis will be required for WAP services to succeed [12]. Several WAP services have failed because of a mismatch between their information architecture and the users’ tasks. Although poor task support is a serious usability problem for a big-screen web site, it is a usability catastrophe for a small-screen WAP service.

4. GUIDELINES FOR DESIGNING WAP-APPLICATIONS

Ramsay and Nielsen conclude, in a report on their field study of WAP users in London conducted in 2000, that WAP doesn’t work [12]. They ran this field study in London because of the advanced state of the United Kingdom’s mobile phone market relative to the United States. Their results show that accomplishing even the simplest of tasks takes too much time to provide user satisfaction. They do, however, add that good user interface design can alleviate some of the problems currently facing WAP services. Their study also revealed that the usability problems encountered were not as a result of the WAP phones. The WAP users had no trouble using the phones; the usability problems were inherent to WAP and cannot be fixed by means of new phone designs. The results of their study did, however, provide empirical evidence to support several key guidelines for designing usable WAP applications.

Several other authors have also done usability studies on specific aspects of WAP usability [3], [5] and [6]. These guidelines are summarised under the headings Content, Navigation, Display and Usability Requirements below.

4.1 Content

Not all content suits the WAP environment [13]. WAP users do not want to read a lot of text. Information content needs to be customised for the mobile environment [12]. Research has shown that the following guidelines can be used to assist with design choices:

- Use numbers for input whenever possible.
- Use common abbreviations like country codes (e.g. ‘ZA’ for South Africa).
- If letters are used, keep the input mechanisms in mind, e.g. preferably the first letter on a button.
- Offer choices (e.g. numbers, list boxes, radio-buttons, link-lists) or default values when applicable; even long link-lists prove viable because of scrolling.

4.2 Navigation

Navigation on WAP-enabled phones is based on the same principles as the Internet [12]. Users select options from successive menus until they find what they are looking for. Alternatively, users can turn to a search engine or search facility to help them. With small screen devices, it is important to design for economy of navigation. Users will be frustrated by scrolling through long lists of options, filling out complex searches and clicking successive links to drill down through a hierarchy. The following guidelines can be used to facilitate navigation:

- Navigation should prioritise key user tasks. Links from the homepage should be kept to the minimum number possible. Although users will scroll, this is a time consuming activity and a small screen means that in long lists, top items will be forgotten before the end is reached.
- Menus should be ‘wide’ as opposed to ‘tall’. Each time a user follows a link, a delay is inevitable, meaning that number of clicks is an important measure of efficiency in the WAP environment.
- Navigation should always feature a clear ‘back’ link returning the user to the previous page.

4.3 Display

The display design should consider the specific properties of the target device [11]. Small devices can only support the most basic interaction, while larger devices allow for complex interaction using a stylus or alphanumeric keyboard in combination with a relatively high-resolution display [13]. The following guidelines can be used to assist with display design [7]:

- WAP services should be tested on a variety of different devices to ensure the integrity of the design independent of presentation or physical navigation method.
- As some WAP browsers may not underline links, try to establish a meaningful convention to denote links that the user will understand intuitively at first sight.
- Any graphical logo design must work within the confines of the screen. A tall logo may be illegible to the user and merely confuse.
- Menu items should contain a maximum of 16 letters in order to ensure legibility. If text does wrap, ensure that words themselves are not broken.
- As with other media, assist the reader by emphasising key points and formatting to assist scanning. Use bold text rather than underlines, which may be taken for links by users with web experience.
• Use multiple cards in one deck instead of very large cards or multiple decks.

4.4 Usability requirements

There are several usability requirements that must be taken into consideration when designing the interface [7]:

**Ease of use:** It is known that most mobile device screens are small. The user must therefore be able to browse through the site and do his or her task with minimum difficulty.

**Consistency:** Consistent screen design will help the users in understanding how to browse and what they must do when on the WAP site.

**Speed:** WAP-enabled mobile devices are still a very new technology. Currently, bandwidth and memory capacity are limited and therefore the speed with which these devices can access information on the Internet, is slow. This will limit the type and amount of content that can be placed on the WAP site.

**Reliability:** The site needs to be reliable so as to minimise maintenance and problems that might occur which would hinder the viewing of information.

5. WAP TECHNOLOGY

WAP applications were initially developed using the Wireless Markup Language (WML) only. WML is the HTML of the wireless web. Like HTML, WML is a display markup language that supports layout, input and navigation as well as inclusion of images and scripting [2]. WML is an extension of the eXtensible Markup Language (XML) that was developed to specify data definitions for structured data. WMLScript is a scripting language that extends WML so that you can validate user input, display dialogue boxes and access local resources. WML and WMLScript can be used to create content and format the display of the information on a mobile device. WAP gateways parse and encode the WML and WMLScript content before sending it to the WML browser (see Figure 1).

Technological advances have solved some of the problems of engineering applications for multiple mobile devices [11]. XML documents supported by XSL (eXtensible Stylesheet Language) stylesheets allow the creation of customised presentations for different devices or users. WML thus facilitates the development of device-independent presentations for a range of small display devices. Wireless Internet gateways automatically translate HTML documents into WML documents (although they may produce unusable results if they rely on large displays). XSL (and related technologies) help with user interface presentation, but are limited by the fact that a different interaction design may be necessary when moving between radically different device types. While these solutions help with parts of the problem, they do not provide high-level guidance for guaranteeing quality across multiple versions of applications.

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**Figure 1: Architecture of a WAP Gateway**
6. USABILITY EVALUATION

WAP users are not sitting in front of a PC. They are on the move or on their way to a meeting. Building usable WAP systems is not straightforward, and the goal when doing so should be to make it as simple to use as possible [10]. While this is true for any application, it’s an absolute must in the context of WAP [12]. WAP users are subject to many distracting events in the environment that surrounds them, and this adds to the input/output limitations of WAP phones (see 4. Guidelines for Designing WAP applications).

Questions that need to be answered when evaluating the usability of a WAP application, include the following:

- Is the application easy to learn?
- Is the application efficient to use?
- Are unusual operations easy to remember?
- Do users get stuck when there are errors?
- Are users likely to be frustrated by their attempts to use the application?

A usable WAP application should never confuse users, in that users should ideally be able to find the most obvious operations intuitively - just one click away.

7. EXAMPLE WAP APPLICATION

LEG (www.leg.co.za) is a web site that provides the public with information concerning restaurants and entertainment in the Eastern Cape region. The public can access the website and find information on local restaurants and entertainment, or reviews on specific restaurants, shows or events (see Figure 2). Due to LEG’s current success it was decided to broaden the public base and allow information to be accessed through the use of mobile devices, most importantly that being cellular phones.

7.1 Requirements Analysis

As discussed in the guidelines above, it is essential to determine exactly what information should be provided by a WAP site and what tasks should be supported [12]. A WAP site should not try to reflect the same content or services as its equivalent web site [13]. A questionnaire survey was thus conducted to determine the information needs of the potential users of the Wireless Entertainment Guide (WEG).

Thirty users consisting of scholars, students and lecturers were surveyed early in 2002 to determine their potential information needs.

The results of the questionnaire survey indicated that certain information was regarded as essential, while some information was optional and other information was not required. The essential and optional items were combined to determine the information requirements of the WEG site. This information consisted of restaurant and entertainment information, including details of restaurant venue, contact details, price range, cuisine, menu and features. Viewing or entering a review of a restaurant was not required. For entertainment, the essential information required was a list of artists or bands, a list of shows or events, an event calendar and a list of forthcoming events. Once again, entering or viewing a review of a show was not required. This information was then used to construct a detailed task model for the WEG site.
7.2 User Interface Design

Using the guidelines discussed in 4 above and the generalized task model, the user interface for the WEG site was then designed. This design was prototyped using different WAP simulators. A WAP simulator or emulator is a device in which you can create and test WAP applications that you design in a virtual environment [2]. It also allows you to browse WAP sites and shows you what the content looks like through the screen of a specific cellular phone. The specific simulators used during the beginning phases of the project were the Nokia simulator called the Nokia Mobile Internet Toolkit (http://www.forum.nokia.com/main/1.35452.1_1_50.00.html), and the Siemens simulator called the Wireless Companion (http://www.yourwap.com/marketing/en/6/6_5/6_5.php). These simulators provide an authoring and simulation environment for mobile Internet content such as WAP, XHTML Basic, and Wireless CSS.

Figure 3 shows the main screen of the WEG site on the Nokia and Siemens simulators. The LEG logo was taken from the LEG website and converted into a WBMP format that is recognised by cellular phones. The logo is used to identify the WEG home screen from the other screens on the site. If the cellular phone does not support images, as in WML 1.1, alternate text will be displayed. Note that on the Nokia phone, the Options link is displayed while on the Siemens phone, this facility is represented by the word Link.

The first option on the main menu is the Restaurant link. This link leads to various other screens in which the user can search for a restaurant either using an alphabetical category or by typing in the first letter of the restaurant in question. Once the restaurant is found, a meal type and a price range for that restaurant will be displayed. If the restaurant name link is chosen, the user can view a short description of the restaurant and also view its speciality dishes and details.

The second option on the main menu is the Entertainment link. From here, the user has the option of viewing shows/events, artists/bands or venues. The shows/events option provides information concerning events currently taking place. It displays the event name and also the date on which the event will take place. There is an option to view the event venue. The artists/bands option provides a description of the artist or band selected. The venues option allows the user to search for venues either using an alphabetical category or by typing in the first letter of the specific venue. Once the venue is chosen, its address and telephone number can be viewed. There is also an option to view the schedule for current and forthcoming events.

The third option on the main menu is the Event Calendar link. The user can select a particular month, enter a specific day, and then a list of events occurring on that day is displayed. A short description is also provided about the event.

The fourth and final option on the main menu is the Search link. This allows the user to enter the specific restaurant name or event and the necessary details are displayed.

Figure 3: Main Screen of the WEG site on Nokia & Siemens

Figure 4: Main Menu of the WEG site on Nokia & Siemens
8. FUTURE RESEARCH

The WEG site still remains to be fully implemented and tested. An analytical evaluation of the usability of the WEG site was conducted using a heuristic evaluation [9] and a cognitive walkthrough [8]. This evaluation revealed no significant usability problems with the design of the user interface. User satisfaction still needs to be determined, however, using empirical evaluation methods [1].

The penetration and usage of WAP applications in South Africa is still very small. Many users worldwide, however, see the potential in the mobile Internet [12]. Further research is needed in South Africa to determine exactly what are the key WAP applications and refine the design guidelines for South African users. It is clear that mobile Internet will not work in South Africa in 2002 but it may work in the foreseeable future. More case studies, like the WEG site, are needed to explore the possibilities and the design challenges that need to be faced.

9. CONCLUSIONS

The wide range of mobile devices available has become a fundamental challenge for the designers of WAP applications. Advances in mobile technology, like XML and XSL, have solved some of these problems, but further assistance is needed to ensure usability and user satisfaction. Designing usable applications for mobile devices requires a user-centred design approach, with a careful task analysis of the users’ goals and information needs. Empirical research into WAP usability has also provided several guidelines that can be used to ensure easy, effective and efficient access of relevant information using WAP devices. The development of the WEG site has demonstrated how a user-centred design approach together with the use of these guidelines can be utilised to ensure a satisfactory user experience. More research is needed, however, to fully explore the potential of WAP applications in South Africa.

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11. REFERENCES


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