DEVELOPING SUCCESSFUL MOBILE APPLICATIONS

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ABSTRACT

This paper discusses issues related to developing successful mobile applications both businesswise and in terms of user satisfaction. It shows that despite the many limitations mobile devices have, it is worthwhile considering developing them. Mobile commerce may become the key driving force for developing mobile applications, just as electronic commerce catalyzed the development of Web applications. This paper puts special emphasis on goal-driven applications, and suggests seven key principles for developing highly goal-driven mobile applications. Finally, the importance of mobile usability evaluation is emphasized.

KEY WORDS

Mobile applications, software engineering, design principles, evaluation.

1. Introduction

Mobile data networks together with the Web provide companies and organizations with many new possibilities. With third and fourth generation digital media phones, broadband digital wireless networks, and mobile hypermedia, new concepts for electronic commerce and communication can be studied, modeled, constructed and measured. The mobility of users calls for malleable patterns of conducting electronic business, because handheld portable devices have many restrictions, such as a small display, limited input facilities, small memory, small computational resources, and a narrowband network connection. For this reason, it is highly important to obtain a deeper understanding of user interaction with these personal virtual environments, and to learn to design better mobile applications.

This paper aims at highlighting key issues related to developing successful mobile applications. In as the same way that electronic commerce catalyzed the development of Web applications [1], mobile commerce may become

the key driving force for developing mobile applications. For this reason, we place special emphasis on mobile commerce by outlining an m-commerce related scenario and discussing its potential applications (section 2). We then assess the differences between the Web and mobile applications (section 3). A variety of mobile and m-commerce applications exist, many of which can be described as goal-oriented. In this paper we emphasize the goal-driven approach and propose seven key design principles for highly goal-driven mobile applications, and also discuss the measurement of mobile usability (section 4).

2. Mobile applications

2.1. Scenario

Brenda Davis is a 25-year-old woman living in New York City. She is running a small one-woman catering service and therefore has to drive around the city a lot. Her parents recently bought her a WAP-enabled mobile phone, as they wanted to be able to be in touch with her anywhere and at any time.

At first Brenda was quite skeptical about the device, but after a while she noticed how useful it really was for her business. For example, just before she is about to jump into her car, she can check the traffic situation from her mobile phone with just a few clicks and see if there will be any heavy traffic on the route she is planning to take. The phone may suggest possible alternative routes and notify her of traffic jams and accidents in the city as soon as they are reported. See Figure 1.

Brenda can also shop with her mobile device. She likes hip-hop music, and so she can access a mobile service which sells music. This service is capable of making recommendations based on Brenda's consumer behavior and the behavior of other users who have ordered the same CDs. In addition, if the CD she has ordered is late for some

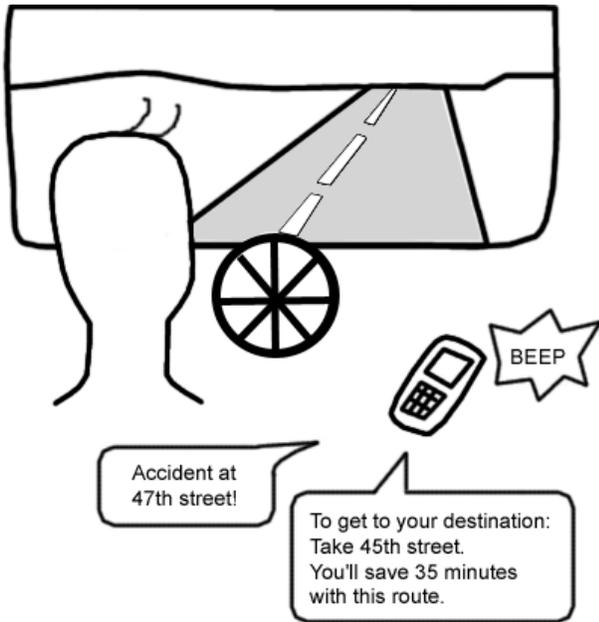reason, Brenda can check the situation using her mobile device.

Figure 1. Contextual information just on time.

Brenda likes baseball and enjoys swimming on hot days. She may order a push message, for example, on the final score of a baseball match. In this way, she will know the result as soon as the game ends. Or she can receive personalized messages based on her mobile profile for recreation.

The conclusion is that the mobile device has made Brenda's life easier, with respect to both business and pleasure. The above scenario describes only some of the possibilities attached to mobile devices.

2.2. Examples of m-commerce applications

Mobile commerce and mobile communities are among the key driving forces of mobile applications. The range of potential mobile commerce services is practically unlimited. Varshney and Vetter [2] have defined classes of m-commerce services (see Table 1).[1] Example application areas include financial applications, advertising, and inventory management. The comparing of products from different vendors may become even more difficult with mobile terminals than with the Web, however, and new

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[1] It should be noted, however, that the currently available technology and markets are not ready for all these services.

solutions are needed to tackle this problem. The need for information intermediaries and brokers may also increase.

Table 2. Classes of m-commerce services [2].

Class of services	Examples
Mobile financial applications	Banking, brokerage and micro-payments
Mobile advertising	Sending user specific and location sensitive advertisements to users
Mobile inventory management	Location tracking of goods, boxes, troops and people
Proactive service management	Transmission of push messages, e.g. about traffic jams and changes in bus/flight timetables
Product location and shopping	Locating/ordering certain items from a mobile device
Wireless re-engineering	Improvement of business services which take place on the move
Mobile auction or reverse auction	Services for customers to buy or sell certain items
Mobile entertainment services	Video-on-demand and other services to a mobile user
Mobile office	Working from traffic jams, airport and conferences
Mobile distance education	Taking a class using streaming audio & video
Wireless data center	Information can be downloaded by mobile users/vendors
Mobile music/music-on-demand	Downloading and playing music using a mobile device

The classes of mobile services described in Table 2 can be further divided into two groups: user-oriented and provider-oriented. When the user is the one who controls the use of the service, it belongs to the former group, whereas when the provider sends advertisements etc., i.e. is the one who makes the initiative, then it belongs to the latter group. Some services can be placed in both categories, however.

As can be seen from the following text, most of the service classes described in Table 2 belong to the first group (user-oriented), which includes mobile financial applications, mobile inventory management, product location and shopping, mobile auction or reverse auction, mobile entertainment services, mobile office services, mobile distance education and mobile music/music-on-demand. The provider-oriented group, on the other hand, includes mobile advertising and wireless re-engineering. In addition, two of the classes listed in Table 2, proactive service management and a wireless data center, can be placed in both groups. This is because the user can play as significant a role as the provider when these services are used. When it comes to proactive service management, the user is the one who orders the messages, but the provider is

the one who actually sends them when a certain condition is fulfilled. In the case of a wireless data center, information can be downloaded by either the user or the provider.

3. Differences between the Web and mobile applications

There are differences between the Web and mobile services, in terms of the *device* itself, the *network*, the *user* and the *usage context*. Mobile devices have a relatively small display size,[2] and the display also differs in shape from the traditional desktop computer. There are also constraints on their input possibilities, CPU, memory, bandwidth and data transfer rate, they have a high latency and they are more costly to use than the WWW via a modem [3]. It is clear that mobile devices can be used best for limited purposes (see Table 2), whereas they are not usually capable of performing advanced graphical transformations or content filtering operations, for instance [4].

Table 2. Key limitations of mobile services.

Limitation	Mobile services	Desktop computers
Small display	Yes	No
Limited input possibilities	Yes	Depends on the device
CPU	Yes	No
Small memory	Yes	No
Limited bandwidth	Yes	No
Small data transfer rate	Yes	No
High latency	Yes	No
Cost of use	Yes	No

Although the device and the network are the most visible differences between the Web and mobile services, the biggest difference in fact lies in the users. People who use Web sites usually know at least the basics about how to use a computer and the WWW, but users of mobile services are not necessarily familiar with these (see Figure 1). In addition, users of mobile services have highly varying needs, and often tend to be impatient. They are not likely to browse with the device, as this would cost too much and would be too slow, and surfing with a small display would be agony [3].
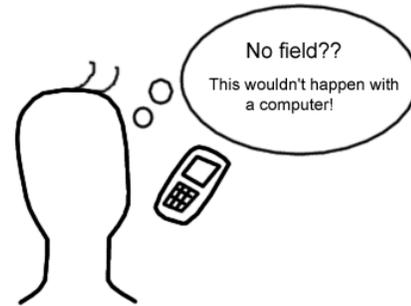
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[2] Mobile devices can be divided into three groups: two-way pagers, mobile phones and PDAs (Personal Digital Assistants). Communicators form a hybrid group, being at the same time both phones and PDAs.

Figure 2. A key to successful mobile applications is to break away from the traditional way of thinking about computing.

Another great difference between mobile and Web services is the usage context. Mobile services are generally used "on the move", and users cannot concentrate fully on the usage situation because the environment can be very noisy and distracting. Use is task-oriented, in that mobile services can be used to find a specific piece of information, e.g. to check one's bank balance. The tasks should therefore be easy and quick to complete [3]. It has been claimed that every press of a button reduces the number of potential users by 50% [5]. The reason for this behavior is that users will either get lost, become bored or run out of time.

4. Design of highly goal-driven mobile applications

4.1. Key design principles

According to Ramsay and Nielsen [6], mobile services can be divided into two groups: *highly goal-driven* and *entertainment-focused*. Highly goal-driven services aim at providing fast replies to specific problems, such as "What is the stock rate for company X's shares?" whereas entertainment-focused services enable the user to pass the time, e.g. by offering gossip, games or sports results.

Based on Singhal et al. [3], we have defined seven principles for highly goal-driven mobile services:

1. Such services should provide information that users need when they are on the move (Mobility).

2. They should make the life of their users easier (Usefulness).

3. They should include only relevant information (Relevance).

4. They should be simple and easy to use (Ease of use).

5. The most important information should be the easiest to locate (Fluency of navigation).

6. They should use their users' terminology and their navigational structure should be organized in the way in which users think (User-centeredness).

7. They should be adapted to each and every user's own needs and capabilities (Personalization).

These principles can be summed up further in one sentence: *A good mobile service provides additional value for the user and is fast and natural to use.*

Successful mobile services may, of course, have many other desirable features in addition to the above. They may provide information on situations that change rapidly, for instance, or information that needs to be received immediately a change has occurred.

Because of their restrictions, mobile applications are often incapable of giving broad overviews or providing detailed contextual information, which are very important for supporting user orientation.[3] In fact, orientation and fluent navigation becomes even more important with mobile services than with Web services, because of the small display size, the usage situation and the cost of using the devices. Users of mobile services also seem to prefer searching with keywords rather than browsing.

Although direct manipulation is a key means of interaction, application developers should not rely on it entirely. By matching user profiles and content meta-information, personalized mobile applications can be built that offer the exact information the user needs or wants. Personalization becomes a very important facet for mobile hypermedia.

4.2. Measuring usability

High usability should always be guaranteed in mobile applications. A research vehicle developed by Oinas-Kukkonen [7] allows us to examine the relationships between the feeling of positive user experience (flow), perceived usefulness and ease of use of the system, the feeling of control, skills at using information technology, perceived challenges, learning, focused attention, and

fluent navigation (and also actual purchasing behavior when available). A study of mobile user perceptions [8] found fairly strong correlations between perceived usefulness, fluent navigation and positive mobile user experience (see Fig. 3), the results suggesting that satisfaction in navigational capabilities, which is a central facet of ease of use, seems to be a key variable explaining positive mobile user experience.[4]
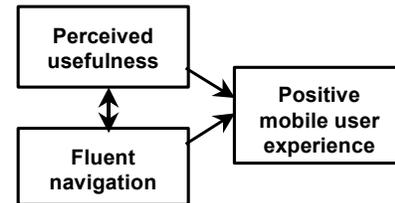

Figure 3. Prerequisites for positive mobile user experience [8].

According to Ramsay and Nielsen [6], the generally weak usability of contemporary mobile services comes from using "traditional" design guidelines without considering the changes that mobility has introduced into the process. Some guidelines remain the same when one enters the mobile world, such as simple, natural dialog, speaking the users' language, minimization of user memory load, and the need for consistency, but some additional usability guidelines emerge that are specific to mobile services. These emphasize that the service should be easy, fast and comfortable to use, the navigation structure should be clear, simple and shallow, users should be required to input as little information as possible, the services should include only the information users really need, the content should be divided into small chunks, and it should be organized according to the tasks that users want to perform.

These guidelines sound very rational, but how do we really know that our mobile services are usable enough when the development cycle is finished? The answer is simple: by taking real users into design and development work and by performing usability studies throughout the process. Many usability problems can be avoided by following the above guidelines, but some things just have to be tested with real users in order to be sure. Many books discuss usability [9, 10, 11], but practical situations may, of course, be very different from an ideal case.

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[3]The only contextual cues currently used in mobile services are often the structural links "previous page" and "next page", or sometimes headers, although some devices/ browsers do not display headers at all. This is rather similar to the situation in the early days of Web pages.

[4] Well-designed navigational structures are independent of the technological platform, while usability is highly platform-dependent. For this reason, the usability of services varies between technological platforms, while conceptual navigational structures may remain the same.

5. Conclusions

Despite the many limitations inherent in mobile devices, it is worthwhile considering the development of such applications. There is a general danger of over-emphasizing the current limitations, while more attention should perhaps be paid to the upcoming better-equipped devices and applications developed for them. In as the same way that electronic commerce catalyzed the development of Web applications, mobile commerce may become the key driving force for developing mobile applications. Furthermore, *the development of mobile applications should not be about reducing content and functionality but about creating new, innovative ways of using information technology in place, time and user sensitive contexts*. The mobile design principles of mobility, usefulness, relevance, ease of use, fluency of navigation, user-centeredness and personalization may help us to achieve this. In any case, solid functionality and high usability should always be guaranteed in mobile applications.

Acknowledgements

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