Handheld handholding: small-screen support for museum visitors

Sarah McDaid
London South Bank University
Borough Road
London, UK
mcdaids@lsbu.ac.uk

Silvia Filippini-Fantoni
Cogapp
Lees House
Brighton, UK
silviaf@cogapp.com

Matthew Cock
British Museum
Great Russell St
London, UK
mcock@thebritishmuseum.ac.uk

Increasingly museums are developing information systems and guides to be accessed from small mobile devices. Some of these initiatives utilise proprietary hardware and software that can require substantial development resources. More recently museums have had the option to target personal mobile devices, (e.g. Apple iPhone or Google Android handsets) which potentially require a lower investment cost on the part of the institution. While the sophistication of these handheld devices means that a large volume of information can be stored and displayed, the challenge for museums is to provide usable access via the small screen area available. Taking examples from work done during the development of the British Museum multimedia guide, this paper discusses the processes and techniques available for usability testing in a 'live' museum environment and shows how the use of low-cost usability and user testing techniques can be quickly fed back into the development process, making a valuable contribution to the ultimate design and effectiveness of the user interface.

Handheld, mobile devices, museums, usability, interactive maps

1. INTRODUCTION

Over the last decade many larger museums have developed multimedia visitor guides for handheld, personal digital assistance (PDAs). Many of these initiatives utilise proprietary hardware and software and can require substantial development resources both in terms of costs and manpower. However, the general growth in popularity of smartphones (e.g. Apple iPhone and Google Android phones) means that the option now exists to target these mobile devices as a download platform for museum guides and edutainment applications.

According to a recent Mintel market research report (Mintel International Group Ltd. 2010), of the 94 per cent of people over 16 in the UK, who use internet at home, 28 per cent of them have a smartphone. This is over double the number who owned one in the year previously. The potential of this market has prompted some of the large multimedia guide producers to extend into Apple iPhone app development (e.g. Antenna Pentimento (Antenna Audio Inc 2011)). With the market penetration of smartphones growing, they have increasingly become a cost effective platform for museums of all sizes to leverage for the deployment of interactive guides and other mobile applications. In general such devices require a lower investment cost on the part of the institution in technology, development, deployment and distribution support. This is due to the use of standard technologies, ability to leverage common tools, availability of commodity skills, and lower expenses on hardware, support and maintenance.

While the sophistication of these handheld devices means that a large volume of information can be stored and displayed, the challenge for museums is to provide usable access via the small screen area provided. In addition it is useful to reflect on the lessons learned from the failure of previous generations of mobile technologies such as Wireless Application Protocol (WAP). WAP phones were the first generation of mobile internet devices and when they were launched, at the end of the last century, they were hailed as a 'killer' technology. Their ignominious failure in the market place could be largely attributed to the poor usability of the interaction.

Figure 1 *Sample screenshots from the British Museum multimedia guide*

Usability testing has traditionally been carried out in a specialist laboratory environment and as a result can be seen as an unaffordable option for many museums. Alternative and more cost-effective techniques are also available, some of which are highly applicable for evaluating the usability of mobile devices. These can help to ensure successful product acceptance in an environment where the consumer is often a first time or infrequent system user and the options for training prior to use are very limited or non-existent.

2. MOBILE DEVICE USE IN MUSEUMS

A variety of screen-based mobile guides have been piloted or adopted by a range of museum worldwide since the turn of the century. This is mainly due to the great potential that such solutions offer to museums and their visitors. Advantages include: variety of interpretation, engagement of visitors, outreach to new audiences, support for orientation and flexibility with content distribution. The Experience Music project in Seattle was a pioneer, introducing in 1995 a portable, if somewhat bulky device. In 2002, Tate Modern introduced the first wireless Multimedia Guide pilot, which has been commercially available to the public since 2005. Following Tate's example museums like the Louvre and the Centre Pompidou, have now completely replaced their audio offering with multimedia for both temporary and permanent exhibitions (Filippini-Fantoni et al. 2008). Since 2008 the use of screen-based mobile guides in museums has further increased, with the arrival of the Apple iPhone and other smartphones on the market, which have resulted in the development of apps for use on visitors' own mobile devices.

In line with the increasing use of screen based mobile devices in cultural institutions, the British Museum recently undertook a one year project for the development of its own multimedia guide, the first version of which was launched in December 2009. Figure 1 shows sample screenshots of the current guide incorporating the amendments made after user testing.

In brief, the British Museum multimedia guide uses an Antenna Audio proprietary device (XPvision) with a 320x240 touchscreen and is available in 11 languages (English, Korean, Arabic, French, German, Italian, Japanese, Mandarin, Russian, Spanish and British Sign Language). In terms of content, the guide currently provides audio descriptions, filmed interviews with curators and conservators, 360 degree views of selected objects as well as contextual material in the form of photographs and music for over 230 objects in the collection. Access to the information on these objects is provided by way of a virtual keypad, which allows visitors to type in the number of selected works on display and play the relevant commentaries. In addition, in order to support visitor orientation and way finding the guide includes:

- an interactive map of the museum's three floors, which by zooming and scrolling and/or inputting the room number into the keypad, allows the visitors to understand where they are and plan what they want to see and where they want to go;
- a choice of 7 guided tours with audio-visual directions between objects, combining audio instructions, with images of landmarks and the path highlighted on the map;
- an application called the "Museum Navigator", which provides audio-visual descriptions of the location of selected objects, galleries and facilities (e.g. restrooms, lifts, stairs, cloakroom), without relying on location-aware technology.

Way finding, in particular, is a key component of the British Museum guide. This is because orientation around the building can be particularly challenging for visitors to the museum. When considering the best possible way to support them in this process, the museum looked into various location-aware technologies, such as Wifi, RFID, Bluetooth, IR, etc. However, after exploring the available options, it was decided not to adopt any of the existing solutions due to reliability issues, budget limitations, maintenance and time constraints. This meant that the museum had to opt for a way finding and orientation approach that could be manually controlled by the user via an interactive map and/or a series of guided tours.

Given the difficulty of developing a manually controlled way finding solution using a small screen based device, it was important that the museum follow an iterative, user-centred development process, which allowed for the progressive refinement of the tool based on the results of a series of usability tests carried out throughout the project. Involving the user in this process was of fundamental importance to the success of the guide, particularly in view of the additional usability challenges that mobile devices present, compared to other platforms. A fuller description of the development of the guide and results of the evaluation can be found in Filippini-Fantoni et al. (2011).

3. MOBILE DEVICE USABILITY CHALLENGES

The world of mobile computing and mobile devices is a fast changing one. Over recent years a growing amount of research has looked at how the features of these devices and their context of use impacts on their usability, the user experience and the challenges it creates for usability testing (Buchanan et al. 2001; Zhang et al. 2005; Bertini et al. 2009; Nielsen 2009). This research suggests that some of the limiting characteristics of mobile devices can be their:

- relatively small screen size/resolution which has an impact on how much information can be displayed at any one time and also how it can structured;
- limited input methods which consequently, for most types of input, take longer to complete and are more error prone;
- limited processing power and battery life;
- lack of homogeneity of operating system and physical design;
- reliance on a possibly limited network connectivity and/or bandwidth.

While much of this research looks at mobile internet access, many of the challenges identified are also applicable to handheld multimedia guides. The small screen, in particular, results in users having to place more dependence on their short-term memory which generally makes interaction harder (Nielsen 2009). Therefore, when designing for input through a touchscreen and output of information via a small screen careful consideration needed to be made of the visual layout and information architecture of the guide as these can have an impact on the usability of the system and the user experience. As a stand-alone edutainment device, the British Museum multimedia guide is of course not affected by network connectivity and/or bandwidth issues.

4. USABILITY EVALUATION OPTIONS

There are a range of usability testing techniques that can be employed by user experience specialists throughout the design and development lifecycle of a system. These include a number of cost-effective techniques such as paper prototyping, usability inspection and user testing. For the iterative development process described here, it was considered that the most appropriate combination of techniques to use was heuristic evaluation and user testing.

Heuristic evaluation is a cost-effective usability inspection method in which usability experts review an interface for possible issues based on their own development experience and a series of design “rules”. A variety of suggested heuristics have been published, some of which have been adapted for evaluating mobile computing (e.g. Nielsen 2005; Bertini et al. 2009). In particular, Bertini et al. (2009) assert that specific heuristics are needed for mobile devices to take account of their non-static context and use.

In terms of conducting user testing of mobile devices, such as the multimedia guide, the main question to consider is which of the 2 main methods i.e. laboratory or field studies should be used. Based on a survey of mobile usability testing literature, Zhang et al. (2005) have developed a framework for the selection of an appropriate method for testing the usability of mobile applications. This framework confirmed that as the objective of the user test was to determine usability in a real life context the appropriate method to use was a field study using the actual mobile device. This decision was further supported by work done by Nielsen et al. (2006) which showed that significantly more usability problems are identified in field-based evaluations than in a laboratory environment. Specifically, this style of study is more likely to identify those particular problems and issues associated with the interaction style and cognitive load.

5. USABILITY TESTING AT THE BRITISH MUSEUM

The user testing exercise at the British Museum was done as part of the on-going guide development project and focused on the English language version created for use by adults. One of the main requirements of the evaluation was to identify any usability issues in a timely manner in order that feedback could be provided to the multimedia guide development team to support the iterative, rapid application development process. In addition to the formal user testing, informal/'agile' heuristic review feedback was given at regular intervals throughout the development cycle.

The first round of "in-the-field" user testing of the multimedia guide involved 9 participants and took place in February 2010, after the launch of the first version of the guide. A further round of user testing was done in March 2010 with 7 participants to analyse the impact of the interface changes and new features before the release to the public. While these numbers of participants may appear small it has been shown that they are sufficient to find more than 85 per cent of usability issues (Nielsen 2000) and keeping the study numbers at these levels also helps to make usability testing faster than empirical methods.

Figure 2 *Participating in the usability test*

For the study participants were asked to complete a series of tasks that included listening to the welcome message, identifying the different features and icons of the guide and taking one of the guided tours (Ancient Egypt). In addition, they were asked to find an object with a commentary on the guide and listen to it using the keypad. In order to test the interactive map feature they were asked to find their current location, as well as adjacent and particular rooms. They were asked also to find objects with a commentary and listen to them using only the map.

The participants were observed performing each task and were encouraged to use the guide as they would if visiting the museum on their own (figure 2). Among the observations made, any problems that participants encountered were recorded, as was the context in which the issues arose and how they were resolved (or not). If necessary, participants were probed in order to clarify unexpected actions and/or problems that they were observed having with the tasks and which they seemed unable to solve themselves. When a task was completed a short semi-structured interview was conducted which encouraged the participants to elaborate on their experience, confidence in using and satisfaction with the features of the guide they had just encountered. In total each test took between 60 and 90 minutes to complete.

Over the same time period (January to February 2010) the museum was conducting a survey of visitors who had used the 'live' version of the multimedia guide which was currently available for hire. The survey was completed in the language in which they had used the multimedia guide. While most of the survey was aimed at collecting demographic, general usage, content and administration information about multimedia guide users it also included a number of questions concerning difficulties visitors may have encountered while using the guide. The nature of the results from each of the evaluation methods is discussed below.

6. RESULTS OF THE EVALUATION

It should be remembered that as well as identifying areas that might cause concern, usability testing also highlights those areas that are working well. In general, the issues raised when evaluating the multimedia guide were of a low severity level as they did not stop participants completing their tasks. In general, the test participants reported that they enjoyed using the guide and the majority described it as fun. In particular the guided tours were very popular with the participants and the virtual keypad was easy for all users to understand and use.

Each evaluation technique (questionnaire, heuristic review, user testing) identified similar areas to revisit but to different degrees of granularity. A sample of the usability issues discovered during these evaluations is described below.

Analysis of the survey data provided some quantitative information relating to the number of visitors who used a particular feature of the guide and any general issues they had with them. Of all the people who completed the survey (n=425) 58

per cent said that they had no difficulty using the guide at all. However, of those who did report a difficulty the highest percentages occurred around the interactive map. A total of 172 people tried the map and almost 26 per cent of them reported that they had a difficulty using it in general (e.g. scrolling, zooming, selecting objects) and 22 per cent also had a problem orientating themselves using the map option. The next most reported issue related to finding the objects in the galleries which had a commentary available on the guide (11 per cent of 425). The questionnaire identified general areas of difficulty, as was its purpose, but the nature of the data collected was not sufficiently detailed to allow changes to be made to the interface.

When compared to the process for conducting the questionnaire, the usability evaluation methods described here had tangible benefits in terms of the speed with which tests could be designed, conducted and reported on as well as the usefulness of information that it provided for the development team. Importantly while the questionnaire showed that there was a definite issue with the interactive map, the user testing was able to determine more specifically the challenges the users were having with its use. In particular it showed that the way in which the map zoomed in and out was not clear or intuitive to them and the overall greyscale colour of the map interface made some of the smaller icons disappear into the background, so much so that many users did not notice them at all.

In addition, as the user test was a field study rather than one done in a laboratory, issues associated with the context of use were also highlighted. For example, a problem was discovered with the amount of time some of the way finding images remained on the screen during the guided tour. It became apparent that while following the audio directions between objects many users didn't hold the guide but walked with the device simply hanging around their necks. At certain points during the directions they were instructed to look at the screen to view a landmark image. However, on some occasions by the time they had picked up the guide and focused on the display, the image had disappeared from the screen.

Both the user testing and the heuristic evaluation identified areas of concern relating to recognition of particular objects based on the images used in the guided tours, areas of inconsistency with the general museum signage and lack of visibility of some object stop icons. However, the heuristic review also identified usability issues in a number of other areas relating to cognitive load and short-term memory capacity, support for the development of mental models of both the system and museum, inconsistency of actions and the use of a non-standard icon requiring users to learn and recall its meaning rather than recognise it.

As a result of the usability testing a number of enhancements were made to the design and structure of the guide. In particular adjustments were made to the interactive map zoom facility and colour-coding was added making it easier for users to distinguish the different galleries. This brought the style of the map on the guide in line with those displayed in the museum itself. In addition, to support the limitations of human short-term memory and reduce cognitive load on the user, the welcome message was simplified, a general orientation section was included and the 'how to use guide' was restructured. The second series of user tests showed that this combination of enhancements resulted in increased confidence in the use of the guide and the participants' ability to find their way around the museum.

7. CONCLUSION

Usability testing, as part of a user-centred design process, plays an important role in the development of all interactive systems. It is an efficient and effective method for not only identifying potential usability issues but also establishing those areas of a design that are working well.

Due to the added complications inherent in the use of mobile devices for example, context of use, lack of homogeneity of products, it is important also to consider how testing will be done. Effective usability testing of mobile devices must take account of specific considerations including designing for a small screen, supporting short-term memory limitations, and reducing cognitive load. As a result it may be necessary to employ more than one technique in order to provide sufficient insight. A number of usability testing techniques are available and each has its place in providing a specific, different and complementary perspective. In effect each technique allows us to identify different things about the system being evaluated. It may also be necessary to select and tailor techniques to meet specific requirements. Frameworks such as Zhang can help with these decisions.

The usability techniques described in this paper including heuristic evaluation and user testing can be extremely cost and time effective solutions for museums of all sizes. *In situ* testing can be considerably more economic than the use of a specialist laboratory and can also provide more useful results through better contextualisation. In conclusion, user testing of the British Museum

multimedia guide enabled the development team to quickly resolve the concerns that were identified and a second study showed that the changes and enhancements to the system had resolved the main issues.

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