

Integrating Potential Users Into the Development of a Medical Wrist Watch in Four Steps

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Abstract. The focus of this study was on the integration of potential users into the development of a mobile medical device from the first idea up to a finished prototype. Apart from medical functions the special feature of this mobile small screen device is its completely icon based menu structure. In three consecutive studies the requirements concerning the design and usability of the wrist watch and its functionality were evaluated. A specific impact had the design of the, warning functions and the icon development that should be easily understood by affected users. In a fourth study, the developed prototype of the mobile small screen device was tested according to usability aspects and comprehensibility of the menu structure. Beyond chronically ill users, which were the target users, a group of healthy users served as control condition for evaluation purposes. Overall it could be shown that a completely icon-based menu structure on a small screen device is not only feasible, but also highly suitable if the design is following a completely user-centered development and evaluation procedure.

Keywords: Mobile devices, icon recognition, medical devices, hardware design, usability.

1 Introduction

Icon based menus have a lot of advantages compared to text based menus, especially in a medical context. Text-based menus are problematical for several reasons. The linguistic terms used to indicate an item's functions, such as their assignment to function classes (category headers) are oftentimes ambiguous and difficult to comprehend [1]. Furthermore, the representation of linguistic terms is space consuming thus wasting a resource of increasing scarcity and are, in addition, hard to read for vision-impaired persons [2]. Finally, text-based menu structures establish language barriers, a crucial disadvantage in times of increasing globalization.

In times of demographic change and the resulting increased demand for technical and medical assistance it is indispensable to integrate the needs of potential users in the design process of new (medical) devices. Moreover, everyday life is determined by globalization. It is thus important that persons with different linguistic and cultural backgrounds are able to understand the meaning of signs to gain access to a technical device [3]. Therefore, an icon-based menu-structure is favorable – provided the users

are able to deal with it. For this reason it is most important to create a menu structure and a user-tailored icon design that are intuitively understandable. If this succeeds, a completely symbol-based navigation is space economical, intuitively understandable and independent of the linguistic background. To create such a menu, it is most important to have a good research base - especially for the healthcare context, in which medical necessity and critical time frames are crucial. The medical context is very sensitive. A healthcare device has to meet many more requirements compared to conventional ICT-devices. Medical assistance is often connoted with unpleasant attributes like vulnerability and illness. Devices equipped with medical monitoring functionality (e.g. monitoring cardio-vascular data anytime and anywhere) might cross personal intimacy boundaries, raising concerns about privacy, data security and maybe loss of control [4]. Also, users show a higher heterogeneity concerning their cognitive and physical abilities in this context [5]. This is another important point that has to be considered while creating a menu structure for a small screen device in the healthcare section. Considering the potential advantages of an icon-based menu over a text-based menu structure for small screen devices and the challenging requirements medical functionality implies in addition, it is indispensable to integrate users into the whole developing process of an icon based small screen device in order to understand needs, barriers, and usability requirements. Users are considered as experts for needs and concerns towards a (new) technology and novel device designs, because in the end, the success or failure of a product depends on the user's decision. Thus, our research focuses on the integration of the user into the developing process.

2 Method and Results

In this section the used methods and key results for each of the four steps are presented.

Step 1 – Understanding User Requirements Concerning a Medical Mobile Small Screen Device. The first step contained the development of a survey in order to get an understanding of the user's requirements on a mobile small screen device. A group of 64 people affected by diabetes or heart diseases (age 13-78 years) and a group of 30 healthy people (age 19-61 years) took part in this study. The aim of the survey was to evaluate disease specific user characteristics, special needs of ill users towards an "every day helper" and to answer the question which characteristics a "mobile small screen device" should have. Results revealed that diabetics have indeed other requirements than cardiac patients. Whereas reliability and safety aspects are most important for cardiac patients, diabetics emphasized design aspects of a mobile small screen device and the need for keeping control over their disease and not to relinquish it to a technical device. The stressed importance of design aspects in the diabetics group might be due to the younger age of diabetic participants (compared to the cardiac group).

Step 2 – Uncovering Users' Mental Representation of Navigation Items. In a second step, the sign production method was used to uncover mental representations

of menu items [6]. A sample of 28 participants (age 17-55 years) was requested to draw suggestions for the graphical representation of 51 reference functions of a mobile small screen device half which contained disease specific functions. Based on the results, icons were developed and in a further study validated by asking users (N = 45, age 23 – 68 years) to label the symbols according to their function and to test whether the symbols are recognizable in different colors and sizes even on small displays. Based on these criteria a total of 42 icons were selected in the end.

Step 3 – Blink, Sound or Vibration? Thirdly, we conducted a computer based empirical testing to find out what an alarm design of a medical device should look and sound like (N = 36; age 21-72 years). In this step, different usage contexts were taken into account (at home, supermarket, work) and four different warning modalities (sound, color, luminance, movement) were evaluated. The main study objective was to find an appropriate way to warn the user in case of emergency and to remind the user of daily activities like medication. Results clearly revealed that user prefer context sensitive warning modalities that express the urgency of the warning through a specific color. In the working context all users emphasized the importance of a discrete signal with pulsating light and no sound signal with exception for urgent emergency cases in which a medium sound would be accepted. In contrast to that, a warning or reminder signal in a supermarket or at home should be in medium noise in any case. For simple reminders participants preferred green pulsating light and yellow for urgent warnings. Blink or flicker was never chosen as option for light movement whereas all participants valued a vibration as best modality in every context.

Step 4 – Ease of Use and Usability. The last step of the evaluation procedure was directed to the testing of the developed prototype of the mobile small screen device. The main focus was the comprehensibility of the menu structure and readability. The aim was to get a realistic idea of the ease of use and the usability of the icon-based menu structure. Within the usability test, we used thinking aloud as a method to understand participants' attitudes, feelings and cognitions when working on the wrist watch. The first half of the testing was free exploration and the second half required task solving. Additionally, participant observation by video was applied. A total of 20 people took part in this study (age 30-79 years). Participants got no instructions how to handle the device neither in the first part of the testing nor in the second in order to evaluate its self-explanatory character. In addition to the two practical trials participants were requested to fill in a questionnaire that contained several control aspects like technical experience especially with touch screen devices or whether one needs glasses. Altogether participants were able to handle nearly all functions of the device on their own. The sole exception were the two disease specific functions which half of the tested group did not understand until they got information from the experimenter on the disease specific purpose of these functions. Icons were, even for the oldest participant (79 years), readable and understandable. Generally no major age-related differences were uncovered and even experience with touch screens had no influence on the usability of the device. The most positive remarked characteristic of the device was its warning and reminder function as well as the touch screen.

3 Discussion

The outcome of our research showed that an icon-based menu navigation is easy to handle for users of all ages. All tested users appreciated the idea of a mobile small screen device for assistance and monitoring in case of diabetes or heart diseases and the finished prototype in the end was evaluated very positive regarding its functions. This fact might be the result of the detailed evaluation of user requirements from the early beginning of the design process. Through the extensive evaluation of the designed icons and their practicability on the base of the survey, a menu structure was designed which was easy to handle for the users. Nearly all icons showed little ambiguity when used in the context of the medical device. The participants were able to navigate through the menu successfully and showed a high comprehension of the structure and the meaning of the items although conditions in the usability test were really difficult due to the fact that participants got no instructions how to handle the device. Based on our findings it can be concluded that the integration of the user from the early beginning of a design process provides a guarantee for a device that meets the demands regarding usability and ease of use in all age groups. Also, the advantage of an icon-based menu over a text-based menu as mentioned in the beginning can be seen as being confirmed.

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