



User interface metaphors for a PDA operating system

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ABSTRACT

This study proposes three novel organizing metaphors for PDA operating system: 'personal computer', 'day planner', and 'gadgets in a bag'. Eighteen initial metaphor candidates were generated from a user survey. The initial metaphor candidates were screened to reduce the number of finally prototyped metaphors that were used in an evaluation experiment. A user-involved experiment was conducted to examine the usability of three final metaphors, 'personal computer', 'day planner' and 'gadgets in a bag' in addition to the existing 'Pocket PC OS'. The metaphor type and learning factors were manipulated in the experiment. Number of clicks, task completion time, and number of errors were measured while the subjects were performing function search tasks. Subjective usability scores and overall satisfaction were also gathered after each treatment condition. The results showed that the day planner metaphor was proved superior in terms of the objective measures, i.e., the number of clicks, task completion time, and the number of errors. Meanwhile, with respect to the subjective measures (i.e., metaphor usability score and overall satisfaction), the three metaphors (i.e., personal computer, day planner, gadgets in a bag) were better than the Pocket PC OS. This study showed that the usability of the existing Pocket PC OS can be improved by introducing a new organizing metaphor appropriate to the PDA. The metaphors proposed in this study are expected to provide valuable insight into the design of future PDA operating systems and application programs.

Relevance to industry: The usability of a personal mobile device such as a PDA can be improved by adopting an appropriate user interface metaphor. The metaphors proposed in this study may be considered as an alternative organizing metaphor when developing a new operating system for those devices.

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1. Introduction

The Personal Digital Assistant (PDA), also called palmtop computer, is one of the most popular mobile devices in the information age. According to Gartner Dataquest (2007), worldwide PDA shipment increased by 39.7% year-on-year at 5.1 million units in the first quarter of 2007. Recently, more mobile phones are being also used as PDAs as the distinction between the PDA and smartphone is getting blurred (Mossesgeld, 2006). The PDA enables the users to access and manage their personal information when they cannot use their personal computers (PCs) (Buyukkokten et al., 2000, 2002). Using a PDA, for example, travelers can check and update their itinerary, and shoppers can carry

a list of items to buy. Originally invented as a stand-alone device, the PDA has become in fact a very powerful handheld computer thanks to the advent of wireless technology (Tilley et al., 2001). Not only is the user able to send or receive e-mails via the wireless Internet, but they can also access a huge amount of information on the web, such as travel information, latest news, and traffic information.

Although PDAs have many merits as mentioned above, they are much less popular than PCs. The reasons include small screen size, limited storage space and battery life, slow CPU speed, and unfamiliar user interface. Among them, however, unfamiliarity of its operating system is arguably one of the major obstacles to popularization of the PDA.

This can be addressed by adopting an appropriate user interface metaphor. Metaphor provides a way of "understanding and experiencing one kind of thing in terms of another" (Lakoff and Johnson, 1980). User interface metaphors allow the users to easily infer the way of using interfaces that are novel or unfamiliar by transferring the familiar area of knowledge to an unfamiliar situation. For

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example, operating systems such as Windows, Mac OS, and Linux are designed based on common organizing metaphor of 'desktop' (Cates, 1994). An organizing metaphor denotes an artifact (or artifacts) mainly used for depicting the interface. Therefore, although a user encounters a new operating system on a PC, he or she could learn how to use it in a relatively short time. However, there is no common organizing metaphor for the PDA. That means even experienced users, not to mention novices, are likely to be in trouble when they encounter a new PDA.

Currently, there are two major operating systems for PDAs: Windows Mobile and Palm OS. Microsoft Corporation's Windows Mobile (also known as Windows CE), as the name suggests, is very similar to Windows operating systems for PCs both in its outlook and user interfaces. Since it was designed as a companion of the PC, emphasis has been placed on easy integration with the PC systems (Zuberec, 2000). Naturally, it attempts to exploit the existing knowledge and experience of PC users by applying the same desktop metaphor as in the PCs.

However, this PC emulating strategy has been criticized in that the desktop metaphor is not appropriate for a handheld computer. Del Galdo et al. (1998) stated that desktop-like metaphor and direct manipulation philosophy of the PC, though taken by many mobile product vendors, are inappropriate for the design of mobile products due to the difference between mobile and office contexts. Haitani, in his conversation with Bergman, also argued that copying design paradigm of the PC into the PDA is not appropriate since the usage patterns are opposite to each other (Bergman and Haitani, 2000). According to his study, people use handheld devices frequently for a short time, rather than infrequently for long sessions as they use laptops. Jones et al. found that a reduced screen size affects the user's approach to the information retrieval task (Jones et al., 1999). They noted that their results suggested the metaphors useful in desktop environment might not be the most appropriate for a small screen device.

The Palm OS takes a different approach. Instead of mimicking the PC, it adopts its own organizing metaphor for the context of the PDA use. The organizing metaphor of the Palm OS is 'pen and notepad'. The pen and notepad are the artifacts that people often carry with them, and thus goes well with the portability of the PDA. They also fit well to the PDA users' interaction style (the way how users input and output information), since making notes and looking them up are very popular tasks in the PDA. However, the 'pen and notepad' concept is not suitable for representing the overall information structure such as menus and folders. This might be why this concept is not as popular as the desktop metaphor in the PC. In a similar vein, Del Galdo et al. (1998) also indicated that a new interface metaphor should emerge in line with the development of user interface technology and better understanding of mobile contexts.

In the last decades, a considerable amount of work has been made on the metaphor as an aid to the use of mobile devices. However, most of them dealt with partial or secondary metaphor for specific application, and little attention has been given to the organizing metaphor that underlies the PDA operating system. Siio and Tsujita (2006) proposed an interaction method so called 'paperweight' metaphor to provide seamless switching between scrolling and editing operations in handheld devices. User interface metaphors were also used for effective contents presentation and environment control through the PDAs. Butz and Krüger (2006) presented 'peephole' metaphor as a model of information access and presentation in ubiquitous computing and instrumental environments. Similarly, Shirehjini (2004) proposed an interaction metaphor based on a 3D visualization of the environment for intuitive access to personal media and environment. Laurini and Servigne (2007) examined various metaphors for city websites

and the possibilities of adapting those metaphors to small screens of the PDA. Other major applications include mobile learning (Chen et al., 2002; Parsons et al., 2006; Weal et al., 2007), health care (Alsos, 2005), and air traffic control (Buisson and Jestin, 2001).

This study aims to propose organizing metaphors appropriate for the PDA operating system. The new metaphor should not only provide effective representation of the information structure, but also embrace interaction styles peculiar to the PDA. A proper interface metaphor can improve the intuitiveness and/or learnability of a product. In addition, it may help the designers empathize with the users. The metaphor can serve as a medium through which designers can predict the user's anticipation on the system behavior, thus facilitating user-centered design. Last but not least, it can help the interface designers to keep the whole interface consistent. Therefore, an appropriate organizing metaphor for the PDA may improve the ease of use (especially for novice users) and also be of great help to the PDA software developers and interface designers.

2. Development of PDA user interface metaphors

There are three approaches related to interface metaphors: operational, structural, and pragmatic (Carroll et al., 1988). According to Levialdi (1990), three questions are asked of metaphors related to these approaches: "Do they really work?" (operational), "What are they made of?" (structural), and "How do they work?" (pragmatic). These approaches can be thought of as complementary (Carroll et al., 1988; Levialdi, 1990; Marx, 1994), and should be integrated to apply various aspects of metaphoric effect to a system and ultimately to enhance the usability.

Therefore, a metaphor development methodology should incorporate all the three approaches. In order to achieve this, metaphor candidates appropriate for the target product need to be created by structural analyses at the design phase. Adequate metaphor candidates should be selected by structural analyses of the relationships between the metaphors and the target interface. Then, an empirical task analysis is performed in order to find out what users actually do and what they will do (i.e., pragmatic approach). The selected metaphor candidates should be evaluated in an experiment involving real users. From the experimental results, the effects of the metaphor will be quantified (i.e., operational approach), and the user's goal and the context of use would be considered during the metaphor development (i.e., pragmatic approach). In this study, the development of user interface metaphors consists of four steps. First, initial metaphor candidates are generated from a user survey. Second, the initial candidates are screened through a formative evaluation and an association test. Then, the features of the metaphors are mapped to the tasks, features, and functions of the target product. Finally, interface prototypes are developed and evaluated in an experiment involving real users to select the best metaphor. The following sections demonstrate this methodology for the case of PDA operating system.

2.1. Generation of initial metaphor candidates

A survey was conducted to generate ideas on the user interface metaphors appropriate for the PDA. The survey questions were asked to those who visited a PDA user group website. One hundred people voluntarily participated in the survey. The mean age of the respondents was 28.2 (standard deviation = 5.72). Most of them (ninety-five) were male. Their occupations were students, office workers, researchers, self-employed businessmen, etc. The following five questions were included in the survey questionnaire:

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