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HOW DO WE VISUALIZE MOBILE DEVICES' CONTENT FOR INEXPERIENCED USERS: A TASK FOR DESIGNERS

KAKO NEISKUSNIM KORISNICIMA PREDOČITI SADRŽAJ MOBILNIH UREĐAJA: ZADATAK ZA DIZAJNERE

Anastasios Politis[1,2] , Chrysoula Gatsou [1,2], Dimitrios Zevgolis [1]

[1] School of Applied Arts Hellenic Open University, Patras , Greece
[2] Graphic Arts Technology, Faculty of Graphic Arts and Design, TEI of Athens, Greece

Abstract

The purpose of the present study concerns the examination of a scenario involving the visualizing of content at mobile devices-platforms and their respective applications. The scenario follows certain design principles that cater for interaction with inexperienced users within the interface of mobile devices. The visual design of an artifact obviously influences the way in which a user will interact with it. Gestalt laws and principles form one possible framework for the collection of helpful design guidelines. Based on field research, a prototype has been developed according to these principles. The results of a evaluation by users on the proposed visualization of content, are finally discussed.

Keywords: *design principles, interface design, mobile interaction, inexperienced user*

Sažetak

Svrha ovog istraživanja odnosi se na ispitivanje scenarija koji uključuje vizualizaciju sadržaja mobilnih uređaja – platformi i aplikacija. Scenarij slijedi određene principe dizajna koji služe za interakciju s neiskusnim korisnicima u sklopu sučelja mobilnih uređaja.Vizualni dizajn artefakta očito utječe na način na koji se korisnik njime koristi. Gestalt zakoni i načela čine mogući okvir za prikupljanje korisnih smjernica za dizajn. U skladu s tim načelima je, na temelju terenskih istraživanja, razvijen i prototip. Rezultati korisničke evaluacije predložene vizualizacije sadržaja objašnjeni su u ovom radu. Ključne riječi: na hrvatskom jeziku

Ključne riječi: *načela dizajna, dizajn sučelja, mobilna interakcija, neiskusan korisnik*

1. Introduction

1. Uvod

The way in which users interact with digital artifacts is obviously of vital importance as it regards mobile devices. How to make possible interactions in a system discoverable is a significant issue in human-computer interaction and the idea of perceived affordances is sometimes used to address the problem.
As Löwgren and Stolterman [1] point out, our designed world is full of digital artifacts. Although digital artifacts rest upon on technical systems, they influence our lives at the level both of the individual and of society.

A display is a central component of a physical UI, because the interaction with a mobile device relies heavily on graphical information and visual perception. Caroll points out that "When we design systems and applications, we are most essentially, designing scenarios of interaction". Visual screen design is vital for both designers and users in their attempts to offer users the ability to interpret visual objects correctly and to interact with artifacts. More broadly, fundamental aesthetic properties, such as colour, layout, and simplicity have been found to predict correctly overall visual appeal ratings across users ([2] Carroll, 1995).

The perceptual abilities of users vary, who therefore have different needs concerning the use of visualization ([3] Ware, 2004). Weeimer ([4] 1995) noted that "the product's appearance can influence one's perception of how easy the product is to use and that a negative reaction to the appearance of, for example, a user interface may mean that the product is not used successfully

Figure 1 *The tablet application*

Slika 1 *aplikacija za tablet*

and so not adopted". Lindgaard et al. ([5] 2007) showed that impressions of the visual appeal of websites form very quickly, within 50 milliseconds. The style in which information concerning the development of some artifacts is visualized is a matter that should be considered ([6] Hackos & Redish, 1998). Mulet and Sano ([7] 1995) argue that "good graphic design can significantly improve the communicative value of the interface, leading to increased usability". However, little research has been published on screen visual representation.

2. Visual cognition – Perception

2. Vizualna spoznaja – Percepcija

Clearly, the user's perception and interpretation of representational graphics is the key to discovering how such graphics are to be used effectively. Thus the nature of visual perception is obviously a crucial factor in the design of effective graphics. An understanding of perception can significantly improve both the quality and the quantity of information being displayed ([3] Ware, 2004). Yet another view regarding the perception of images is given by Petterson stating that the perception of an image is rapid, almost immediate ([8] Pettersson, 1999). In connection with this discovery three assumptions regarding the perception of symbols can be made. First, several different symbols may convey a similar meaning and a specific message. Second, one symbol may be able to convey more than one message. Third, the user has first to learn the intended meaning of symbols. Pettersson states that the concept of "perception" is a collective designation for the processes in which an organism obtains information on the outside world. In the view of Paivio's dual coding theory, the reason why the meaning of icons are likely to be remembered better is related to the fact that the two types of information (verbal and imaginal) are encoded by separate subsystems, one specialized in the handling of sensory images and the other specialized in handling verbal language ([9] Paivio, 1986). The visual system processes and stores more concrete information, such as images, sounds and feelings. The verbal system, on the other hand, processes and stores language and other abstract information. The two systems are independent, but connected. Furthermore, pictures are better remembered than words, because pictures are more likely to activate the image-to-word referential connections, which means that they can be coded both visually and verbally ([10] Paivio, 1971; [30] Moreno & Mayer, 2002).

One of the findings embodied in structural theories of perception is that certain simplified views are easier to read ([3] Ware, 2004). This should be considered, when we want to convey information via screen design. In Miller's view, humans are capable of absorbing more information when they use their eyes, rather than any other faculty ([7] Miller, 1956). The reasons for this have been investigated by such Gestalt psychologists as Koffka, Köhler and Wertheimer [11], who have argued that we constantly search for a 'good fit' between visual image and stored memories of visual objects. This process usually happens very quickly, since visual objects naturally have organised patterns and these are only minimally related to an individual's past experience ([11] Koffka, 1935). Research into visual imagery ([12] Kosslyn, 1980), suggests that visual recall seems to be better than verbal recall. It is not clear how images are stored and recalled, but it is clear that humans have a natural ability in the use of images. Weidemann's results regarding text-based knowledge acquisition and task performance are clearly different from his results regarding the corresponding picture-based performance ([13] Weidenmann, 1989).

2.1 Key laws of Gestalt theory

2.1 Ključni zakoni gestalt teorije

One set of theoretical principles that can help novices construct mental models are the Gestalt laws for pattern perception used in the design of the layout of displays. Any use of a knowledge structure is dependent on users' mental models ([14] Johnson-Laird , 1983). Most modern theories of pattern perception have their roots in the work of the Gestalt psychologists (Carroll, 2003). [15] Gestalt theory is fundamental to visual communication design. It is generally accepted that Gestalt theory may be used to improve screen design and improve user interaction (Preece et al.,1994). In applying the theory of perception to screen design, various aspects must be considered. The Gestalt psychologists believed that perception of objects as a whole differs from the perceiving the sum its parts. They therefore focused on discovering determining principles that might explain how small elements become grouped into a whole. In Gestalt theory, context is regarded as very important to perception. Thus Gestalt laws offer guidance on how a suitable and unambiguous grouping, or division, of visual elements is to be achieved. As a general rule, spatial organization of information, i.e. page layout, must be driven by alignment and balancing criteria. These include similarity, proximity, symmetry, continuity, and finger ground. It is important to keep in mind that each principle, far from operating independently, always works in concert with every one of the others. Screens consist of both visual and interactive elements, which have gestalt properties. Furthermore, in many real-world conditions, Gestalt principles, instead of operating in separation or function independently of one another, usually interact with each other, to promote logical and meaningful perception ([16] Quinlan &Wilton, 1998).

2.2 Gestalt principles used in this study

2.2 Gestalt načela korištena u ovom istraživanju

Similarity: Elements that look similar will be perceived as a being part of the same, which means that elements tend to be integrated into groups, if they are similar to each other. Proximity: Entities placed in close proximity to one another are assumed to be related. This phenomenon is a simple and powerful way of emphasizing relationships between data entities. Symmetry: The law of symmetry expresses the idea that, when we perceive objects, we tend to perceive them as symmetrical shapes formed around their centre. Continuity: Oriented units or groups tend to be integrated into perceptual wholes, if they are aligned with each other. Figure and ground: This is the tendency to organize perceptions by distinguishing between a figure and a background. Fig.2 illustrates the gestalt principles used in this study.

Gestalt principles of perceptual organization ([17] Wertheimer, 1938) play a crucial role in the visual processing of graphical representations. They indicate related functionality and purpose by the use of similar properties, by grouping objects together and by separating objects from unrelated items by the use of "negative" or "white" space. Gestalt principles of perceptual organization make objects in interfaces and the relationships between them more visually striking, thus causing such objects to be interpreted, particularly by novices, in a more detailed and accurate fashion ([17] Wertheimer, 1938).

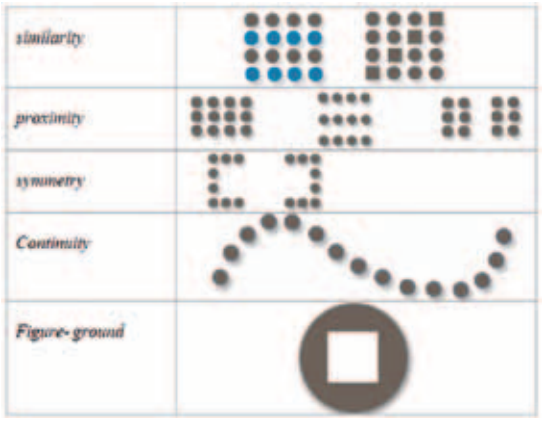

Figure 2 *Illustration of gestalt principles used in this study.*

Slika 2 *Ilustracija Gestalt načela korištenih u ovom istraživanju*

3. Study set up and methods

3. Metode i postavke istraživanja

3.1 User analysis

3.1. Analiza korisnika

Users obviously vary in terms of personal characteristics, physical abilities, cultural assumptions, education and in their expertise in interacting with artifacts. Users also vary in psychological terms, in that they present:

- Differences in perception and attention
- Differences in short term and long term memory and
- Differences in mental models of objects

Norman describes mental models as follows: "In interacting with the environment, with others, and with the artifacts of technology, people form internal, mental models of themselves and of the things with which they are interacting ([18] Norman, 1983). These models provide predictive and explanatory power for understanding the interaction." Mental modes influence perception and thus the way we see and think of the world. This also holds in regard to our perception of user interfaces, our preferences, and how we generally receive and process information ([19] Ito & Nakakoji, 1996).

There are many reasons for the problems that novice users face when using new information technologies, such as ticket vending machings, ATMs or mobile devices, on an everyday level. One problem arises from the pressures felt by designers and developers to add more features and functions. Due to perceptual abilities, users have different needs concerning the use of visualization ([3] Ware, 2004). Another reason is that novice seem to have difficulty in articulating knowledge on which their skills rest, partly because they have little experience on which to base descriptions ([20] Gatsou et al., 2011). Novice users feel frustrated, insecure and even frightened, when they have to deal with a system whose behaviour is incomprehensible, mysterious and intimidating ([21] Baecker & Buxton, 1987; [22] Buxton, 2007). Moreover, a typical user, who thirty years ago would have been a professional programmer, is now an impatient novice ([23] Booth, 1989). Thus today the inexperienced user wants to benefit from such artifacts, as mobile tablets, which, however, are usually complex ([24] Shneiderman & Plaisant, 2005).

3.2 Sketching a concept scenario

3.2 Skiciranje konceptnog scenarija

During this creative process, a rough and sketchy visualization style is required. Freehand design drawings like sketches have been identified as material that stimulates reflection in the early stage of design. Schön [25] points out that drawing is crucial as a tool in this reflecting process. Designers place ideas down on paper and inspect them, during this process, they discover visual cues that suggest ways to refine and revise ideas. This situation is like having a conversation with one's self ([26] Schön and Wiggins 1992). Storyboarding concept screen sketches constitute one effective way of exploring alternative directions while avoiding details of design. This approach allows the user to experience visualized interactions and the structure of the application by means of a creative analysis of screens that can then be designed, evaluated, and explained in more depth. Throughout this phase the preliminary designs are evaluated by means of testing, walk-through and paper mockups, in order to elicit users' comments. Figure 3a shows the sketches of the scenario "first aid" for the four muster screens. This phase is pivotal. The scenario is as follows: the user wants to see first aid information. He selects an icon from the tablet desk top and so selects the first screen. Touching the first screen takes him to the main menu screen, where he can select the specific topic that interests him. From the second screen he can select subcategory, if he wants to enlarge photographs in order to examine details.

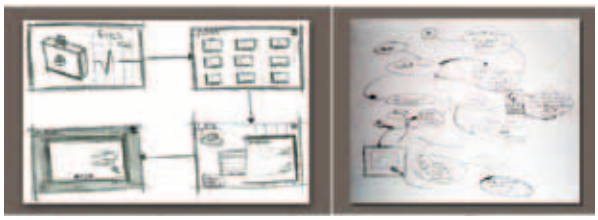

Figure 3 *Storyboard paper sketches of the interaction concept.*

Slika 3 *Skice koncepta interakcije*

These early user observations through sketching (Figure 3b) were an invaluable experience and proved to us several important points. Firstly, we noticed that some older users had difficulty in understanding the metaphor of a home icon used on the navigation button in the main menu. Their past experiences may not have enabled them to understand the meaning of this well-known metaphor. Secondly, that menu navigation tasks could be improved in this phase. These points encouraged us to continue improving the structure and further develop our concept of 'visualising a content scenario for inexperienced users'.

3.3 Content visualization

3.3. Vizualizacija sadržaja

Here we present the benefits of Gestalt laws and design principles when applied to a "first aid" content scenario for a mobile tablet application. An effort has been made for interface to accommodate the context and visual features deriving from these principles, in order to help inexperienced users. Appropriate graphic representation is a vital factor in the correct functioning of mobile applications. For icons to evoke the desired meaning in the viewer's mind, each symbol must display a strong, direct association with the desired meaning, in the mind of both designer and user ([20] Gatsou et al., 2011).

Figure 4 *Visualization of content scenario. Initial screen A, home screen B, category screen C, enlargement of photo details D.*

Slika 4 *Vizualizacija scenarija sadržaja. Početni zaslon A, zaslon B, zaslon kategorije C, povećanje foto detalja D.*

Icons are used here for the home screen that enables users to exploit their experience with mobile phones. To explain the layout of the visual elements in gestalt and graphic design terms: in a screen, balance occurs when all the design elements are equally distributed throughout the design ([4] Weeimer, 1995). Menu preferences, icons and text buttons give a balance to the whole screen. In addition, the home screen uses the law of similarity to allow communication with the content. This is effected by the use of the buttons set inside red bordered boxes, which function as links to the content. This impression is then reinforced by user experience, since all these elements behave consistently. Emphasis indicates the most important element in the layout in terms of the message and is the element that stands out and is noticed first. The initial screen displays a picture of the small white first aid box (Figure 5 a), which is the most emphasized visual element. Lauer notes that, if everything is emphasized, then nothing is emphasized ([27] Lauer, 1979). Finger ground perception helps us to distinguish category headings. This is quickly perceived to be text content (Figure 5c), set on an almost imperceptible background shading (ground).

As for contrast is used the picture is also enlarged, which allows the details be seen more clearly. The application of the red grids to all of the screens employs the use of the principle of rhythm, as we wished to indicate sequential flow (Figure 5 e) As for Symmetry, in the Figure 5f, the 'next' and 'previous' arrow buttons consist of geometrical shapes placed symmetrically. They are clearly pointing in opposite directions, so as to lead the user to next or previous screen. As regards Proximity, in the category screen design, in, for example, Figure 5c, each visual element in the subtitles is identified and clearly placed by grouping them together and by separating them from unrelated items using "negative" or "white" space. As regards Unity, a sentence conveys more information than random words on a page, whilst a paragraph conveys more information than random sentences on the page. Unity is achieved when all the design elements relate to one to another and project a sense of completeness ([28] Resnick, 2003).

Phi (Φ –the Greek letter for "F") is the term used to represent the golden ratio. The Phi Ratio is a proportional relationship commonly

Figure 5 *Screenshots of principle implementation on screen design*

Slika 5 *Prikaz provedbe načela na dizajnu zaslona*

accepted to possess a strong visual beauty and has a long history in the theory of aesthetics. A line can be bisected using the golden ratio by dividing its length by 1.62 (exactly 1.6180339…). A simplified version of the golden ratio is applied more commonly today in graphic arts, photography and design in the form of the "Rule of Thirds." The Rule of Thirds states that people are strongly attracted to objects placed at the intersections of hypothetical lines on a page or in a photograph divided into thirds vertically and/or horizontally ([29] Bezanson, 2007; [31] Lidwell et al., 2003). Phi-based proportions provide an inherent natural sense of beauty, balance and harmony, because these proportions appear so pervasively in nature.

We used the golden spiral (the Rule of Thirds) as a guide for laying out the content of the initial and the category screen. The intention was to guide the viewer's eye to the content help information and to guide him through text and pictures. The basic idea is illustrated in Figure 6.

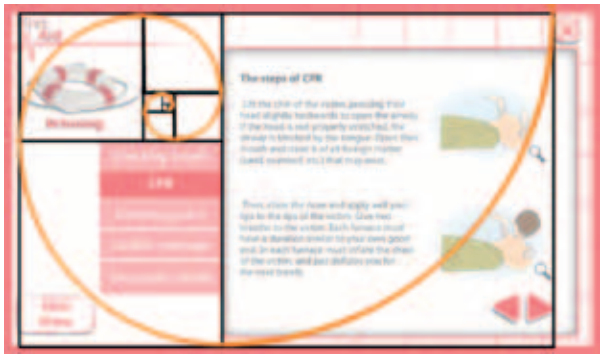

Figure 6 *The use of golden ratio in screen design*

Slika 6 *Korištenje zlatnog omjera u dizajnu zaslona*

4. Results of prototype evaluation

4. Rezultati procjene prototipa

After the design phase and often the concurring with it, the iterative User Centered Design cycle continues to evaluate and test the prototype. The purpose of the experiment was to examine the effectiveness, efficiency and ease of use of prototype. Menu navigation is one of the most common interactions between user and mobile device. We required each participant to complete a mobile device task consisting of nine steps, in a specific order. According to an informal survey, these tasks are typically those first attempted by novice mobile computing users. For some of these tasks, the primary focus was on navigating or searching the menu for some application file that was required.

4.1 Participants

4.1. Sudionici

18 individuals (10women, 8 men) took part in the study. Participants ranged from 15 to 74 years in age, distributed among three age groups. Participants were aged between 15-34 (n = 6), 35-54 (n = 6), 55-74 (n = 6) years of age, respectively. Each subject was given a brief overview of the experiment and briefed as to the purpose and procedure of the study. All participants were mobile computing novices. Participation was voluntary.

4.2 Experimental design variables

4.2. Eksperimentalne varijable dizajna

In order to evaluate task effectiveness, we measured the percentage of steps successfully solved within the set time limit (Table 1). To evaluate efficiency, we recorded the time needed to process the task, results are showed in Table 2. In order to measure ease of use, we asked participants to rate each of the following statements on a 5-point Likert scale (1=strongly disagree, 5=strongly agree): (a) 'It was easy to

complete the task.' (b) 'I felt lost in the menu.' (c) 'It was easy for me to remember how to perform.' (d) 'I did not know where to go next.' (e) 'I was satisfied with the application' (f) 'I did not know how to reach a specific function.'

4.3 Results

4.3. Rezultati

The results arising from the menu navigation task show that not all users make incorrect steps. The results are showed in Table 1 and that the elder participants make more time to complete the task. More specifically, there was a significantly different operating time between age groups.

Table 1 *Specific user navigation steps and user effectiveness (steps successfully solved).*

Tablica 1 *Posebni navigacijski koraci za korisnike i korisnička učinkovitost (uspješno riješeni koraci).*

Steps	***Tasks***	***N=18***
Step 1	Turn mobile device on	94.4%
Step 2	Find the icon for the 'first aid' application	100%
Step 3	Select the icon and go to first screen	83.3%
Step 4	Select information for "heart attacks" via the main menu.	100%
Step 5	Go to screen with "heart attacks ".	94.4%
Step 6	Go to next screen(menu depth: four levels)	88.8%
Step 7	Return to application main menu	88.8%
Step 8	Exit of the application	100%
Step 9	Turn of the mobile device	83.3%

Table 2 *Mean task completion time (seconds) and Std.Dev.*

Tablica 2 *Prosječno vrijeme izvršenja zadatka (u sekundama) i standardna devijacija*

Age group	***Mean task completion time (seconds) and Standard deviations***
15-34(n=6)	84.2 (Std.Dev. =7.0)
35-54(n=6)	96.7 (Std.Dev. =9.2)
55-74(n=6)	127.7 (Std.Dev. =5.1)

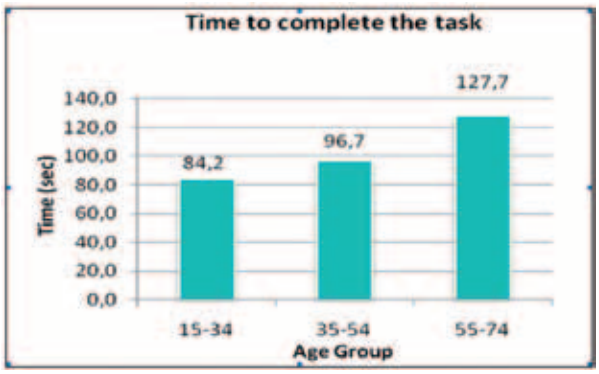

Figure 7 *The interaction effect of age on operating time and mean task completion time (seconds)*

Slika 7 *Interakcijski učinak dobi na prosječno vrijeme potrebno za izvršenje zadatka (u sekundama)*

Subjects' comments regarding navigation indicate that they found the buttons self-explanatory, consistent, permitting them easily to recover from mistakes. Four participants commented that the button for carrying the user to the "next screen of heart attack" in the application menu was not clear. Figure 7gives age groups related to time required to complete the task.

After completing the tasks, participants rated the perceived ease of use of the mobile device. Ratings mirrored the outcomes in performance measures. Users rated the ease of use of the tablet application. The results are given in Figure 8. Participants were asked informally what the most important factor was in learning how to use the mobile device. In their view, being shown through easy, interesting applications was the most important factor, followed by the use of a hand book. Some users told us that they had never used a computer before and that they liked this approach, preferring the touch screen over other environments. Another factor that participants commented on was the ease of use of the menus. Menus are usually complicated and act as barrier between user and interface which affects user interactivity. As Lindgaard points out, user satisfaction is a complex construct that incorporates several measurable concepts and is the culmination of the interactive user experience ([5] Lindgaard, 2007).

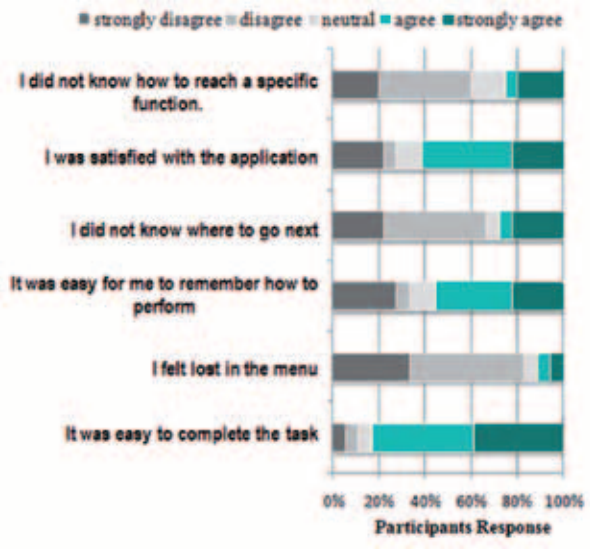

Figure 8 *Participants ratings on ease of use for the application.*

Slika 8 *Ocjena jednostavnosti korištenja aplikacije od strane sudionika.*

5. Conclusions – future work

5. Zaključak - budući rad

Designers are facing the important task to visualize content and information by the most efficient way. This is a difficult task to apply effectively in practice. Different sets of applications require different levels of emphasis of the various elements in the visualization of content and information and also in terms of achieving the most of the perception for users. Designers should act towards three main aspects:

First, they need to design storyboards and prototypes according to theories and knowledge of design, typography and visual communication expertise. Gestalt laws and design principles are the foundation that determines the nature of the mental representations that users generate when viewing a visual screen.

Secondly it is essential that they examine under a systematic way the characteristics of the users and groups, where the specific application is aiming to serve.

The third issue is that they need to test and evaluate the effectiveness of their design through field research with actual sample of users of the certain group. By this way, the designer(s) should create storyboard sketch prototypes, to allow them to gather feedback regarding all levels of the application and its interface.

An analysis of the data shows a large increase in time across age groups. More specifically, there was a significant difference in operating time between age groups. This observation was confirmed by an analysis of the time data, which revealed that age was indeed a significant factor. In general with respect to users' interaction with mobile application strongly support the feasibility of prototype.

From this empirical study, we have learned some basic ideas on how to design effective user interfaces and present contents structurally, so that users may use mobile devices efficiently. We believe that interface design should be carefully considered for usage of the mobile devices by inexperienced users– adding communication capabilities is very important. Exploring the link between interaction, communication, and mobility can be a fruitful and exciting area of research for design of mobile interfaces.

We believe that developing applications to support novice user interaction is an exciting and promising area of future research for pervasive computing applications. The experience we gained will contribute to the design of future interfaces and visual representations of content and information, with a higher degree of ease of access and perception, navigation, interaction and execution of mobile devices applications by inexperienced users.

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AUTORI · AUTHORS

Anastasios Politis

Dr. sc. Anastasios E. Politis; Research Scientist Graphic Arts and Media; Athens TEI and Hellenic Open University; Faculty of Graphic Arts Technology, Athens Technological Educational Institute, Ag. Spyridonos, 12210, Egaleo, Athens, Greece

Korespondencija:
politismedia@gmail.com

Dimitrios Zevgolis

Chrysoula Gatsou