The Recognition & Comprehension on Application Icons on Mobile Devices

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Abstract: With the widespread use of such mobile devices as smart phones and tablets, users can outreach all sorts of information via internet access. The devices have been developed not merely to be "smart" in a multi-functional way but also to be "friendly," as in easy to carry. The development is further on pushed toward friendly interface for users to easily operate so as to access the content without any constraints. From analyzing the relationship between application icons' representation and users' corresponding recognition and comprehension levels, this paper examines those currently used official icons and to understand how the forms and colors within those representations affect users' attention and actions on mobile devices with a comprehension test and semi-structured interviews. The results show that users have difficulty recognizing over one-quarter of the current official icons (24 out of 80, 30%). The degree of accuracy characterizing users' recognition and comprehension for App icons rests on how users interpret the simplicity of shapes and the composition of colors. Furthermore, users' comprehension relates to their imagination and to their cultural background and past experiences. These findings will become fundamental resources for analyzing the visual languages of legible pictograms. *Key words: app icon, pictogram, recognition, comprehension, form and color*

1. Introduction

With the widespread use of such mobile devices as smart phones and tablets, users can outreach all sorts of information via internet access. Information now can be viewed and can be exchanged in and between multiplatform devices. To strengthen users' ability to access information whenever they need it and wherever they go, information-carrier developers have created devices that are not merely "smart" in a multi-functional way but also "friendly," as in ease of handling. This trend has fused hardware and software development and simultaneously has made mobile devices the most popular electronic devices in the current market. As a matter of fact, 3G mobile broadband services have grown to 21.33 million accounts in the region of Taiwan according to Foreseeing Innovative New Digiservices, Taiwan. This figure constitutes 73.6% of Taiwan's total number of mobile users (Jiang, 2012). As for global users, in 2012 there were "about 5.6 billion people using mobile phones in a total global population of over 7.012 billion peoples"(World List Mania, 2012). China and India are the two most populous countries in the world, and it is interesting to compare their respective population size with their number of mobile phone users: China: 1,341,000,000 / 987,580,000; India: 1,210,193,422 / 903,727,208). In terms of the total number of mobile phone users, next in line are the United States, Indonesia, Brazil, Russia, Japan, Pakistan, Germany and Nigeria. Among these countries, several countries' percentage of

mobile users relative to the total population is over 100%, including the United States (103.9%), Indonesia (105.28%), Brazil (127.45%), Russia (154.5%), and Germany (130.1%). These statistics reveal that one user owns more than one device and, more generally, that mobile services have deeply intertwined themselves into our lives.

The services of mobile devices include not merely voice and text messaging but also successful integrations of mobile communications, multimedia, personal document processing, social networking, entertainment, navigation, and many other applications that make vast spreads of information widely accessible to users. With its essential influences on our daily lives, the development of all sorts of mobile services constantly pushes for friendlier interfaces that can free users from constraints. The design of app icons has become a critical part of the success of platforms. App icons enable users to recognize and select important information. Saunders (1994) argued that designers should carefully consider the relationship between users and icons, for messages can be delivered and be received rapidly without language barriers through iconic representation.

From analyzing the relationship between official icons' representation and users' recognition and comprehension, this paper aims to examine currently used official icons and to understand how the forms and colors within those representations would affect users' attention and operations on mobile devices. How simple or complex should the representations of icons be? What color schemes can maximize the efficiency of such representations? To answer these questions, this paper interprets the principles of universal icon design through an information design viewpoint and investigates users' recognize and what they comprehend when using current official icons on most mobile devices.

2. Literature Review

2.1 Mobile Operating System

The marketplace offers a wide variety of mobile operating systems (e.g., mobile OSs, handheld OSs, mobile platforms), including iOS (highest market share) from Apple Inc., Android OS from Google, Symbian OS from Nokia, BlackBerry OS from Research In Motion (RIM), and Windows Mobile OS from Microsoft (Deng & Chiu, 2008). In the battle of internet giants, Android OS (68.3%) and iOS (18.7%) hold a highly competitive position, earning 87% of the market share (Kyle, 2012). Open Handset Alliance (OHA) was founded in 2007 by Google, which acquired Android OS, a Linux-based operating system, in 2005. Its open-source distribution makes the source code of products freely modifiable and accessible. Users can generate content publically, often in a collaborative manner, so that they essentially become co-developers. As of February 14, 2013, Ginger Bread (Android 2.3.x) enjoyed the highest usage figure: 50.8%. Other versions such as Ice Cream Sandwich (Android 4.0.x) and Jelly Bean (Android 4.1.x & Android 4.2.x) have current usage figures of 29% and 6.7%, even though they are newer than Ginger Bread. Mac OS X developed iOS, and Apple's first-generation iPhone was released in June 2007, followed by a rapid rise in sales. The corresponding applications were downloaded from the Apple Store over 1.5 hundred million times in 2009, and there were over 4 thousand million downloads in total as of 2012 (Apple, 2013). This study collected and screened official operating icons from iOS 6.1 (the latest Mac version up to the testing day) and Android 4.0.x (newer version, with the second utilization rate).

2.2 Graphical User Interface

First introduced by Xerox Corporation in 1981, the Star Station (officially known as the "Xerox 8010 Information System") was an operating system that incorporated various technologies and that constituted an early conceptual manifestation of the personal computer. The concept of WYSIWYG represents the key philosophy of the user interface that was to mimic the office paradigm as much as possible in order to make it intuitive for users. Herein, four elements of the graphical user interface (GUI) are noteworthy: windows, icons, menus, and pointers (WIMP) (Fang, 2003). Armed with these elements, the GUI allows a given set of information to be displayed and to be seen on a screen in an intuitive manner.



Figure.1 Compound document and desktop of 8010/40 system. WYSIWYG in Wikipedia: http://en.wikipedia.org/wiki/WYSIWYG. Scanned (2008-05-06) from the undated (c. 1985–87) 8010/40 brochure (8 pp. A4 full color with laminated card cover) distributed by Rank Xerox to promote this product.

GUIs directly or metaphorically represent real objects and mimic scenarios. Graphical and iconic representations provide users with an ease of learning and clarification (Lin, 2012), which have been the aims of the much development in the Macintosh System and later on in the Windows System (Chen, 2006). However, interface designs have required considerable development so that they might merge smoothly into various devices and provide friendly services for diverse users. Lin and Hsu (2013) recently claimed that flexibility, optimization, and images that are provided with various resolution choices are three keys for interface design. Graphical interfaces essentially help establish strong relationships between users and devices so that users can use these devices with satisfactory efficiency and effectiveness.

2.3 Pictograms and Icon Designs

Based on fundamental theories from semiotics and iconology, icon designs for informative purposes can represent cultural metaphors and can bridge cross-regional uses of language. A successful icon design can be worth far more than a thousand words. In short, it is a great means of communication. Developers of icon designs should visualize and organize spatial relationships. Horton (1994) argued that icon design should exhibit an effective organization of space, should accelerate searches for information, should impress users, and should reduce difficulties of related operations. The ways in which users recognize an icon can powerfully influence users' decision making and, consequently, users' actions. To ensure the effectiveness and the efficiency of icons, Wood and Wood (1987) claimed that a successful icon helps users (1) recognize its intended messages, (2) distinguish it from other icons, (3) accept messages without triggering cultural conflict, and (4) remain in line with local and global standards.

Icons as the major visual representation on interfaces can help users access interfaces in an intuitive manner and can simplify and represent complex concepts in lieu of lengthy texts. Previous research has identified several principles for successful screen-based use of icons: (1) icons must be clearly visible, (2) icons must have a size that is consistent in itself and that is consistent with the size of the interface, (3) the contour of icons must be solid and a closed form, (4) most morphed images have traditionally been inside squares or rectangles, (5) icons must feature primary colors to avoid complications, and (6) the design of icons must be compatible with the design of other icons (Gittins, 1986). The official icons of iOS 6.1 are inside a square box with rounded corners. The representations of app icons are various. It is time not only to review the principles of icon design but also to investigate the usability of icons on mobile devices, where most current electronic icons are seen. By doing so, we can define the prerequisites and qualifications for a recognizable and comprehensible icon.

3. Research Method

In order to enhance the effectiveness and efficiency of interface readability, we have investigated users' comprehension of currently used Official Android 4.0 and Official iOS 6.1 App icons. To this end, we conducted a recognition test and semi-structured interviews, interpreted the principles of universal icon design from an information-design perspective, examined the form and color of icons on the basis of basic design theories, and clarified how users recognize–and what they recognize in–current official icons on mobile devices. We collected and screened a total of 215 operating icons from the Official Android 4.0 and the Official iOS 6.1. With purposive sampling (Chang, 2007), eighty icons were selected for the Comprehension Test, including all of the iOS icons. For this study, we adopted comprehension testing from the ISO 9186 model (1) to test subjects' recognition accuracy on icons and (2) to identify and to group icons that lack distinctness. We calculated the results with the weighted values ranging from "correct understanding of the symbol is certain" to "no response given" (Brugger, 1999). In order to understand how the representation of icons would affect users' attention to and operation of mobile devices, we conducted a confusion matrix analysis to clarify those confusion icons and to figure out the features of visual elements that lack clearness. Moreover, we uncovered noteworthy findings about reasoning and misleading points from semi-structured interviews and content analysis of subjects' feedback for further understanding of users' action and reaction.



Figure 2. The framework of research method—eighty icons were selected for comprehension testing, which comprised a (1) a recognition test and(2) semi-structured interviews. Using a confusion matrix analysis and content analysis,

we defined reasoning and misleading points for visual justification.

4. Results and Findings

The results show that subjects had difficulty recognizing over one-quarter of the currently official icons (Level 5; 24 out of 80). In this investigation, sixty experienced artists and designers (half of whom were male and all of whom were between the ages of 20 and 35) participated in this research. More than three-quarters of the subjects were smartphone owners, and one-quarter of the subjects were heavy application downloaders, usually operating smartphones over 30 hours per week. The degree of recognition accuracy and comprehension accuracy for App icons reflected how users interpreted the simplicity of shapes and the composition of colors. Furthermore, users' comprehension was associated with their imagination, cultural background, and past experiences.

4.1 Recognition Test

Results show that 15 of the 80 icons were "highly recognizable" icons, garnering a full accuracy score. These 15 icons consisted of the icons for of Music, Weather, Camera, YouTube, Calendar, Phone, Messenger, Google Chrome, Ol File Manager, Clock (2), Calculator (2), and Gmail (2) (each received a score of 100; see Level 1 in Table 1). Of the 80 icons, 27 tested as "fairly recognizable" icons and 6 of the 80 icons tested as "just recognizable" icons, garnering scores within the 90–99.9 range and within the 80–89.9 range (see Level 2 and Level 3 in Table 1). Of the 80 icons, 8 tested as "barely recognizable" icons, garnering scores within the 70–79.9 range (see Level 4 in Table 1). Moreover, 24 of the 80 icons that subjects had already placed in the Level 4 category were characterized by the subjects as being "unable to recognize" (see Level 5 in Table 1).



Table 1. Five degree-of-recognizability levels regarding application icons submitted to a recognition test.



The fifteen highly recognizable icons show the simplicity and the consistency of representation. Most from iOS—with their squares' rounded corners—depict a thematic pictogram emphasizing the topic clearly and directly. Successful icon design appears to be associated with three important characteristics: concrete depictions, abstract speculation, and experience accumulation. Examples such as Camera (\blacksquare). Clock (\boxdot and \blacksquare), and Ol File Manager (\blacksquare) have simplified, concrete contours explicitly depicting a given item. The icon Phone (\blacksquare) is clear since the telephone handset can represent the telephone itself. Other icons such as Weather (\blacksquare) and Calendar ($\boxed{13}$) are compound visual icons: the Weather icon contains both a pictorial representation of the sun and a numeral representing the temperature; and the Calendar icon contains a pictorial representation tool not only within specific fields of study but also surrounding, or representing, that specific field. In the category of abstract speculation, mathematical symbols represent Calculator (\blacksquare), a popup dialog (message box or dialog box) represents Messenger (\square), and a musical symbol represents Music (\blacksquare). The third category, including the Youtube, Gmail, and Google Chrome icons, involves the application of World Wide Web browsers' logos that are so popular as to be quickly recognizable. This kind of recognition is based on familiarity stemming from subjects' accumulated past experiences.

Table 2. Fifteen highly recognizable icons categorized into three sets.

Fifteen Highly Recognizable Icons							
Concrete Depiction	23'		13	<u> </u>			
	Weather	Camera	Calendar	Phone	Clock	Clock	Ol File Manager
Abstract Speculation	+ - × =	- =		5			
	Calculator	Calculator	Messeng er	Music			
Experience Accumulation	You Tube	Μ	•	9			
(Internet- based)	YouTube	Gmail	Gmail	Google Chrome			

The results of our confusion-matrix analysis revealed that twelve icons were difficult to recognize and were conflated with other meanings and situations. The twelve icons were misidentified (see Table 3) as follows:

- (1) Facetime () was misidentified as "camera," "camcorder," or "video."
- (3) Google Earth (S) was misidentified as a browser (87, 81, 60, or 5).
- (4) Google Latitude (📳) was misidentified as Contacts (💾), People (💷) and Messenger (💽, 🖳, 📟 or 🛄)
- (5) ROM Manager () was misidentified as Game () and Settings () or).
- (6) AnTuTu Benchmark () was misidentified as Game ().
- (7) NenaMark2 () was misidentified as Game () and Gallery (💀 or 🖾).
- (8) Quadrant Standard () was misidentified as Stock ().
- (9) iTunes (⁶) was misidentified as Music (⁴, **6**, or **6**).
- (10) DSP Manager () was misidentified as Music (, or) and Voice ().
- (11) Voice Dialer () was misidentified as Voice ().
- (12) Settings () was misidentified as Voice ().

Table 3. Twelve misleading App icons according to the confusion-matrix analysis.



4.2 Comprehension Test

We invited ten subjects from a previous test to participate in semi-structured interviews regarding how they had read those confusing icons and what they had understood about them. These interviews enabled us to uncover more details about the reasons for the subjects' misunderstandings. According to the results of the interviews, subjects associated an icon's meaning with their accumulated knowledge and experiences, subjects interpreted the iTunes icon (O) as meaning "music player" instead of "music store," subjects initially interpreted the icon latitude (O) as referring to a "map," subjects interpreted the News and Weather icon (\fbox{O}) as referring to either news or weather but not both until after some reflection and discussion, subjects conflated the Place icons (\fbox{O} and O) with references to "latitude" or "map" owing to their interpretation of the red cone shape as satellite-positioning or navigation equipment, and subjects misinterpret the Facetime icon (O) as a recording application because of the image's resemblance to a camcorder or a video projector. Results from this stage of the analysis clarify how subjects viewed and thought about the icons. The interview feedback allowed us, the researchers, to flesh out the results from the recognition test and to more fully understand users' comprehension of the tested icons.

5. Conclusions

From this investigation, we have found significant evidence that many app icons should be improved or even completely replaced for the enhancement of their user-recognition and user-comprehension functions. In uncovering this evidence, we researched how users interpret the form and the color composition of an icon. Our specific findings are as follow:

(1) The accumulation of knowledge and experiences facilitate users' recognition and association processes.

(2) Although several visual elements (e.g., musical symbols) are ubiquitous or, at least, prominent in people's daily lives, users may mix metaphors and analogies in compound visual languages when the design of visual elements is inadequate.

(3) Visual representation in compound languages is critical. The relationship between and the organization of two or more elements can account for an icon's successful relationship with compound elements in conveying clear ideas (e.g., "shop for music" as "music store").

(4) Form and color can quickly attract users' attention and can quickly convey intended ideas. By contrast, unclear or misused visual elements can cause confusion or misunderstanding.

(5) The contours that mimic an object or a scenario must avoid ambiguity. For example, subjects misinterpreted the Facetime icon as an image of a camcorder or a projector chiefly because many subjects interpreted the circle in the middle of the icon as representing a lens and interpreted the triangular shape on the right as representing a camera.

The findings above constitute a fundamental resource for research on visual languages of legible pictograms as they pertain to the design of successful mobile-device icons. Building on our understanding of visual language and of legible, successfully recognizable pictograms, we will propose guidelines for the successful design of mobile-device icons in our next study.

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